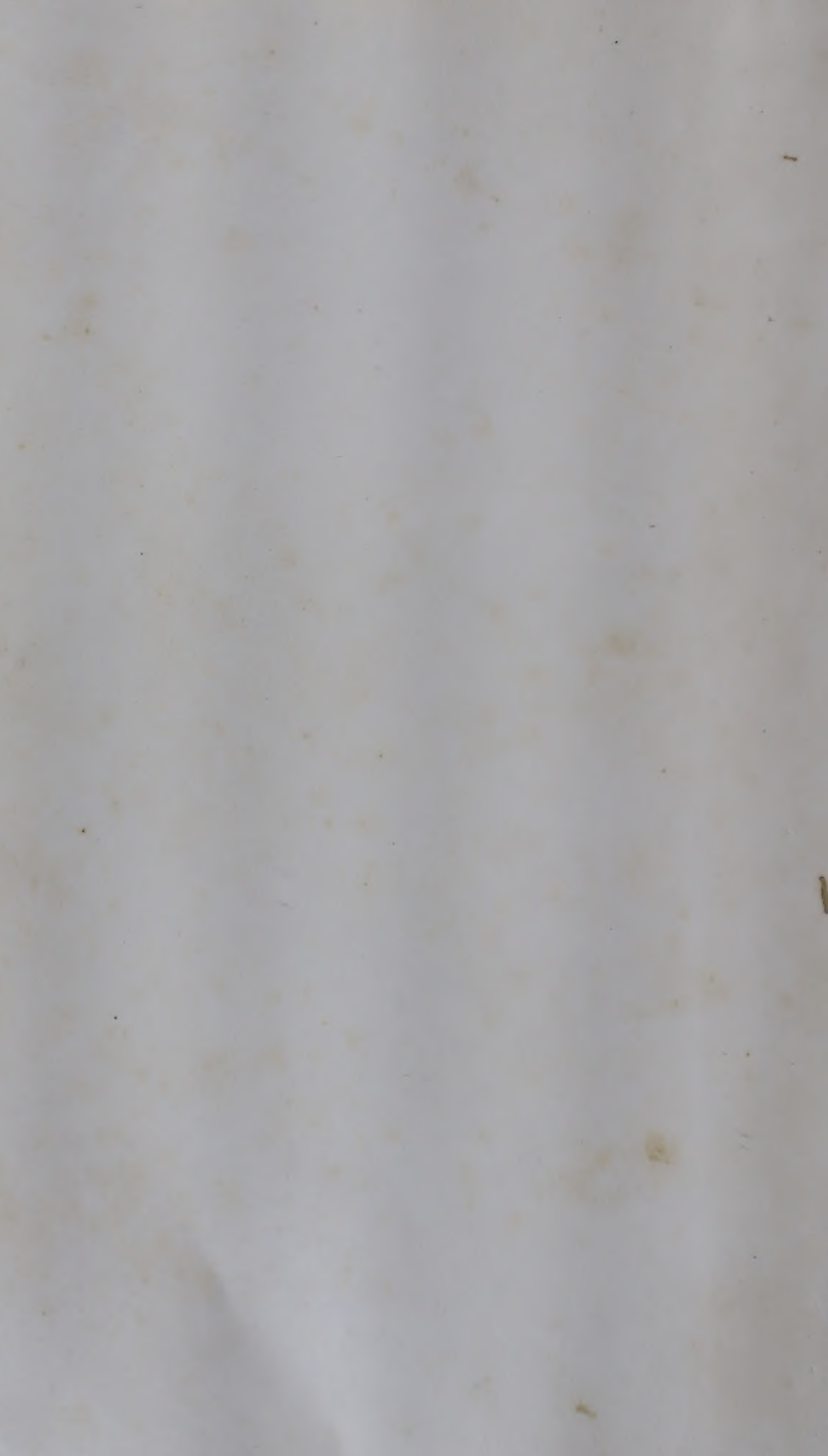


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1959-PART IV-LATE ABSTRACTS,
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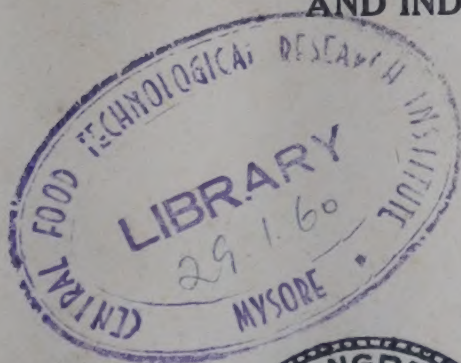


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PROCEEDINGS
OF THE
FORTY-SIXTH SESSION
DELHI-1959

PART IV
LATE ABSTRACTS, DISCUSSIONS, LIST OF MEMBERS
AND INDEX



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PROCEEDINGS OF THE FORTY-SIXTH INDIAN SCIENCE CONGRESS DELHI, 1959

PART IV

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PROCEEDINGS OF THE FORTY-SIXTH INDIAN SCIENCE CONGRESS DELHI-1959

PART IV

LATE ABSTRACTS

Section I, Mathematics

1. Some Two-dimensional Indentation Problems of a Semi-infinite Non-Isotropic Elastic Medium.

BIEHUTIBHUSAN SEN, Jadavpur.

Applying the complex potential method introduced in a previous paper [Sen, Z.A.M.P., vol. 5 (1954), p. 83], some problems of new types of punches on the straight edge of a semi-infinite non-isotropic elastic plate have been considered in this paper.

2. On Meijer Transform of two variables.

S. K. BOSE and A. N. MEHRA, Lucknow.

The double integral relation

$$\phi(p, q) = pq \int_0^\infty \int_0^\infty e^{-\frac{1}{2}px - \frac{1}{2}qy} (px)^{-k_1 - \frac{1}{2}} (qy)^{-k_2 - \frac{1}{2}} W_{k_1 + 1/2, m_1}(px) W_{k_2 + 1/2, m_2}(qy) \times f(x, y) dx dy$$

where $W_{k, m}(z)$ is the Whittaker's Confluent hypergeometric function, is defined as Meijer Transform of two variables and symbolically represented as

$$\phi(p, q) = M[f(x, y); k_1 + \frac{1}{2}, m_1; k_2 + \frac{1}{2}, m_2].$$

This reduces to the Classical Laplace transform of two variables, when $k_1 = -m_1$ and $k_2 = -m_2$.

In this paper we have obtained certain properties of this transform. Further, two of the properties obtained involve self-reciprocal functions in the Hankel transform of order ν_1 and ν_2 .

3. The Consistency of a modified form of Gödel's System Σ .

SHALIGRAM SINGH, Muzaffarpur.

In this article, the consistency of a modified form of Gödel's system Σ , (see K. Gödel, "The consistency of the continuum hypothesis", *Annals of Math. Studies*, No. 3, Princeton, 1940) has been proved. The axioms B_1 , B_2 and B_3 of Σ have been replaced by their modified forms B_1^* , B_2^* and B_3^* respectively to form a new system Σ^* . The modifications are not very marked and hence Σ^* is quite near to Σ . For proving the consistency of Σ^* , a model M^* has been constructed. The interest in this construction in comparison to that of Wang-Naughton (see Hao Wang and Robert McNaughton "Les systemes Axiomatiques de la Théorie des Ensembles" Collection de logique Mathématique, Série A, Paris 1953) lies in the fact that unlike the Wang-Naughton construction the consistency of any system of set-theory has not been assumed herein.

4. Pythagorus Theorem, Trigonometry and Calculus.

J. M. GANDHI, Patiala.

Prof. Elisha Loomi in his book "Pythagorean principle" made the assertion that no independent proof of the pythagorus theorem can be given by Trigonometry, Calculus and Analytical Geometry as they themselves are based on the Pythagorus theorem." L. Cancer (Maths. Mag., Vol. 28, p. 276) gave a proof of the theorem based on calculus, which was discarded by H. W. Becker (Maths. Mag., Vol. 29, p. 40). Author has shown that Cancer's proof was correct (Maths. Mag., Vol. 29, pp. 204-205) and gave an infinite descent method to prove the Pythagorus theorem (Maths. Mag., Vol. 30, p. 250). In this paper several simple proofs of the theorem are given based on Trigonometry and a general method of proving the theorem by calculus and the Loomi's assertion has been discarded.

5. A New definition of Euler's Polynomials and Genocchi Numbers.

J. M. GANDHI, Patiala.

Author has defined Euler's polynomials $G_\gamma^{(N)}(x)$ by the formula

$$2^N e^{xt} / (e^t + 1)^N = \sum_{\gamma=0}^{\infty} t^\gamma / \gamma! G_\gamma^{(N)}(x),$$

while usual Nörlund's definition is

$$2^N e^{xt} / (e^t + 1)^N = \sum_{\gamma=0}^{\infty} t^\gamma / \gamma! G_\gamma^{(N)}(x).$$

With the new definition of Euler's polynomials, author has shown that there is a complete analogy between the results obtained for Euler's polynomials and for Bernoulli's polynomials. The special case of Euler's polynomials, namely $x=0$, $N=1$, has been discussed by Nörlund through tangent co-efficients C_γ , defined by $E_\gamma^{(1)}(0) = C_\gamma / 2^\gamma$, while author has discussed the case through Genocchi numbers G'_γ defined by $G_\gamma^{(1)}(0) = G'_\gamma$. Author has shown that with the new definition, all results are simplified and as $C_N \gg G_N$, and C_N becomes still greater than G_N as N increases, there is a great convenience with the new definition. In the next place author has discussed congruences for Genocchi Numbers analogous to those given by Voronoi, Kummer, Frobenius, Vandiver and Carlitz for Bernoulli's numbers

and author's results are in a more beautiful form than corresponding results given by above authors.

6. On the Isotone Mappings of a Lattice.

A. C. CHOUDHURY, Calcutta.

The object of this paper is to investigate the nature of the system formed by the isotone mappings of a lattice. It is shown here that the system of these isotone mappings form an l-semigroup. Further if these mappings are homomorphisms, then these mappings form a doubly distributive l-semigroup.

7. Bending of a Circular Plate.

LAKSHIMINANYA, Hyderabad.

An extra solution for the bending of an incompressible and isotropic circular plate into a spherical shell has been obtained in terms of the Strain Energy Function W . The forces and couples applied at the boundaries have been calculated.

8. An Extension of the Caratheodory Fejer Problem in the theory of Bounded Analytic Functions.

K. VENKATACHALIENGAR, Bangalore.

Caratheodory and Fejer have proved that if C_0, C_1, C_{n-1} be arbitrarily given numbers and $f(z)$ be any function analytic in $|z| < 1$ having the C_γ as the first n coefficients of its Taylor expansion then M : the least upper bound of $|f(z)|$ in $|z| < 1$ is $\geq \lambda$, where λ is the greatest positive eigen root of the Hermitian Matrix :

$$\begin{vmatrix} 0 & C_n \\ \overline{C_n} & 0 \end{vmatrix} \quad \dots \quad \begin{vmatrix} C_n & \text{Conjugate of } C_n \end{vmatrix}$$

where

$$C_n = \begin{vmatrix} C_{n-1} & C_{n-2} & C_{n-3} & \dots & C_0 \\ C_{n-2} & C_{n-3} & \dots & C_0 & 0 \\ \dots & \dots & \dots & \dots & \dots \\ C_1 & C_0 & 0 & \dots & \dots & 0 \\ C_0 & 0 & 0 & \dots & \dots & 0 \end{vmatrix}$$

and that λ is the sharpest bound. We extend this problem in the following manner. We consider functions $f(z)$ analytic except for r poles ($r < n$) in $|z| < 1$, having its first n coefficients equal to the given C , $r=0, 1, 2, \dots (n-1)$ and prove that if M is the l.u.b. of $|f(z)|$ in $|z| < 1$, then $M \geq \lambda_r$ where λ_r is the r th eigen root of the above matrix arranged in descending order. The bound is sharp in this case also and that the corresponding function is a Fatou-function viz. a rational function with absolute value equal to unity on $|z|=1$, having r poles inside and $(n-r)$ poles outside the unit circle. Some particular interesting results obtained in this connection are the following :

(1) Let $f(z) = 1 + z + C_2 z^2 + \dots$, be analytic in $|z| \leq 1$ except for a simple pole, then the l.u.b. of $|f(z)|$ on $|z|=1$ is $\geq \frac{\sqrt{5}-1}{2}$ (Sharp bound).

(2) Let $\varphi(z) = a_0 + a_1 z + a_2 z^2 + \dots$ be analytic in $|z| < 1$ and $\varphi(z)$ has at least one zero in the unit circle and λ be any given constant, then

$$|\lambda a_0 + a_1| \geq \frac{\sqrt{|\lambda|^2 + 4} - |\lambda|}{2} \quad \text{I}$$

where $\text{I} = \lim_{r \rightarrow 1} \frac{1}{2\pi} \int_0^{2\pi} |f(re^{i\theta})| d\theta.$

We generalise this result further and the most general result obtained is the following :

Theorem—Let z_k , $[k=1, 2, 3, \dots, n]$ be n distinct given points in $|z| < 1$, and $w_1, w_2, \dots, w_n$ be any complex numbers distinct from zero. Then if $w=f(z)$ is any function bounded on $|z|=1$, and regular except for $r < n$ poles in $|z| < 1$, with $f(z_k) = \lambda w_k$, ($k=1, 2, 3, \dots, n$) (λ real, >0) then

$$\lambda \leq \lambda_r$$

where λ_r is the eigen root of matrix formed out of the z_r, w_r and their conjugates. The bound obtained is sharp and the corresponding function is also a Fatou function.

9. On the Determination of the Jump of a Function by Triangular Matrices.

K. C. SHRIVASTAVA, Sagar.

The jump of a function has been determined by Szaz, Chow, Shin-Ichi-Izumi and Kinukawa Masakati. Also Siddique has constructed regular triangular matrices so as to include the extended result of Fejer. The object of the present paper is to construct regular triangular matrix summability, Δ , which will include the summability $(C, 1+z)$ and sum the sequence $nB_n(x)$ to the value $\frac{1}{\pi} D(x)$ at a point of lump under the conditions given below, and thus including the results of Chow, Shin-Ichi-Izumi and Kinukawa Masakati.

$$(i) \quad \int_0^t \psi(t) dt = O(t)$$

$$\int_0^t |\psi(t)| dt = O(t)$$

$$(ii) \quad \int_0^t \psi(t) dt = O(t) \Delta \quad \Delta \geq 1.$$

and $\lim_{k \rightarrow \infty} \lim_{t \rightarrow 0} \int \frac{|\psi(t+\epsilon) - \psi(t)|}{t} = O(\log \frac{1}{\epsilon}).$
(kt) $1/\Delta$

$$(iii) \quad \int_0^t \psi(t) dt = O(t)^{1-\alpha}, \quad 0 < \alpha < 1.$$

10. On the functional boundedness of Solutions of Perturbed differential Systems.

V. LAKSHMI KANTH, Hyderabad.

This is a continuation of the author's works in this field [cf. (1) Proc. Amer. Math. Soc., 1957 and (2) Proc. Nat. Acad. Sci. (India), 1958]. We define the functional boundedness as follows :

A solution $x(t)$ of a diff. equation is to be functionally bounded, if it satisfies a fractional order relation of the type $V[x(t), (t)] = O(L(t))$ as $t \rightarrow \infty$

In this paper, the functional boundedness of a solution of the perturbed differential system is considered. This generalises the existing work in this field.

Section II, Statistics

THEORETICAL STATISTICS

Distribution Theory

1. Some results for the Queue with Poisson arrivals.

N. U. PRABHU, Dharwar.

The queueing system studied is the one in which (a) there is only one counter, (b) the customers arrive at random and are served in the order of arrival, and (c) the service-time distribution has a general form. The distribution of time τ taken for a waiting-time $\eta(t) = x$ to reduce to zero [$\eta(t + \tau) = 0$] for the first time is obtained, and from this are deduced the explicit expressions for (1) the distribution of the length of the busy period and (2) the distribution of the number of customers served during a busy period. Further, the distribution of the time taken for a queue of given length to disappear has also been obtained. The paper concludes with a discussion of the general first passage problem for the waiting-time process $\{\eta(t)\}$.

2. Joint Asymptotic Distribution of U-statistics and Order Statistics.

J. SETHURAMAN, Calcutta and B. V. SUKHATME, New Delhi.

It is shown under some mild restrictions that the joint distribution of a U-statistic and the a_n -th order statistic tend to

(i) the bivariate normal distribution if $\frac{a_n}{n} \rightarrow p$ $0 < p < 1$,

(ii) the joint distribution of two independent variables, one of which is gamma and the other normal, in case $a_n \rightarrow \text{constant}$ or $n - a_n \rightarrow \text{constant}$,

(iii) the joint distribution of two independent normal variables if $a_n \rightarrow \infty$

such that $\frac{a_n}{n} \rightarrow 0$ or $\frac{n - a_n}{n} \rightarrow 0$.

The conditions for case (i) are, (a) the U-statistic is generated by a bounded kernel or by a kernel that is bounded in every bounded interval of its arguments and has a finite third moment, (b) the distribution has a density which is continuous at its p^{th} quantile.

In the second case it is assumed that (a) the kernel of the U-statistic is bounded, (b) the distribution $F(x)$ is continuous and the order statistics normalised as $n F\left(\frac{X}{a_n}\right)$ or $n (1 - F\left(\frac{X}{a_n}\right))$ according as $a_n \rightarrow \text{constant}$ of n - $a_n \rightarrow \text{constant}$.

In the third case it is again assumed that, (a) the kernel of the U-statistic is bounded, (b) the distribution $F(x)$ is continuous and the order statistics normalised as $\frac{n}{\sqrt{a_n}} \left\{ F\left(\frac{X}{a_n}\right) - \frac{a_n}{n} \right\}$ or $\frac{n}{\sqrt{n - a_n}} \left\{ \frac{a_n}{n} - F\left(\frac{X}{a_n}\right) \right\}$ according as $\frac{a_n}{n} \rightarrow 0$ or $\frac{n - a_n}{n} \rightarrow 0$.

The above results are generalised to the case of several U-statistics, several order statistics and generalised U-statistics.

Though the rigorous proof employs the use of characteristic functions, it is easy to see the truth of results by means of the following heuristic argument. As soon as an order statistic is fixed, the conditional distribution of a U-statistic is asymptotically normal, by an application of the Central Limit Theorem. From our knowledge of the limit distribution of the order statistic, the nature of the limiting distribution of the U-statistic and order statistic can be inferred. How this argument can be made rigorous is also indicated in the paper.

3. On the Exact Distributions of a Class of Multivariate Test Criteria.

D. G. KABE, Dharwar.

By explicitly evaluating the complicated characteristic function of $Y = -2 \log$ (test criteria), it has been shown that the frequency function of Y , in some important cases, is identical with the frequency of a linear function of Gamma variates. Exact results have been given. In view of the results it has been shown that better approximations are desirable to the present assumption that Y has a Chi-square distribution.

4. On the Proof of the Lemma Used in Deriving the Distribution of the Second Order Sample Moments for Symmetric p-Variate Population.

B. D. TIKKIWAL and D. G. KABE, Dharwar.

Anderson (Multivariate analysis, mimeograph series, Columbia University, 1952) has given a lemma primarily to derive the distribution, analytically, of the second order sample moment statistics for a symmetric p-variate population in general, and a p-variate normal population in particular. This lemma states that if Y be a column vector of n (>2) components having a density $f(y'y, B'y)$, where the $q \times n$ given matrix B is of rank q , then the joint density of $U = Y'Y$, $V = B'Y$ is given by

$$\frac{1}{2} c(n-q) \{u - v' B B' v\}^{1/2(n-q)-1} |B B'|^{-1/2} f(u, v)$$

Where $c(k)$ denotes the surface area of a k dimensional sphere. Originally such a distribution was derived geometrically by Wishart. Later attempts to give analytical proofs of the distribution were made, because of the fact that the geometrical methods, though appearing elegant and short, are not easy to grasp. However, the pure analytical proofs of the lemma tend to be lengthy. That is why this paper presents a geometric-cum-analytic proof of the lemma.

5. A Note on Skew Bi-Variate Surfaces.

D. N. LAL and J. DUTTA, Patna.

Pearson's partial differential equations of bi-variate surfaces, namely

$$\frac{1}{Z} \frac{\delta Z}{\delta X} = \frac{\text{A Cubic in } x, y}{\text{A Quartic in } x, y}$$

$$\frac{1}{Z} \frac{\delta Z}{\delta Y} = \frac{\text{Another Cubic in } x, y}{\text{Same Quartic in } x, y}$$

are shown to admit the following solutions

$$(1) Z = Z_0 e^{-Q_1/Q_2} (Q_2)^p$$

$$(2) Z = Z_0 (Q_1)^a (Q_2)^b$$

$$(3) Z = Z_0 (1+Q)^{-p} e^{-\alpha \tan^{-1}(ax+by)}$$

$$(4) Z = Z_0 (Q)^p e^{-\alpha/1+ax+by}$$

where z_0 , α , a , b , p , and q are constants, Q is a positive definite quadratic form and Q_1 and Q_2 are quadratic expressions in x, y .

Theory of Inference

6. Goodness of Fit Tests for a Stochastic Process with Non-Additive Linear Components.

K. N. VENKATARAMAN and D. V. RAJALAKSHMAN, Madras.

Consider a non-linear process constituted from the product of m linear stochastic schemes defined by

$$\{X_t\} = \{X_t^{(1)}\} \cdot \{X_t^{(2)}\} \cdot \{X_t^{(m)}\} \cdot \dots \quad (1)$$

where

$$\{X_t^{(r)}\} = \sum_{k=0}^{\infty} \lambda_k^{(r)} \varepsilon_{t-k}^{(r)} \quad r=1 \text{ to } m. \quad (2)$$

and $\{\varepsilon_t^{(r)}\}$ being purely random processes and for any arbitrary set of time points (t_1, t_2, t_k) the m vector random variables $(\varepsilon_{t_1}^{(1)}, \varepsilon_{t_2}^{(1)}, \dots, \varepsilon_{t_k}^{(1)})$ are jointly independent. Under these conditions, it can be shown that $\{X\}$ is a stationary process.

If $C_s(X^{(r)})$, the auto-covariance of order s for the process satisfies a difference equation whose auxiliary equation has all its roots lying within the unit circle, this paper develops an asymptotic test-procedure on the correlogram similar to the goodness of fit tests available for linear stationary schemes.

Take the special case when the auxiliary equation has all the k_r roots distinct and given by $\rho_1^{(r)}$ ($i=1$ to k_r) then the autocovariance $C_s(X^{(r)})$ can be written in the form

$$\sum_{i=1}^{k_r} \mu_1^{(r)} [\rho_1^{(r)}]^s, \quad |\rho_1^{(r)}| < 1$$

where $\mu_1^{(r)}$ is a constant.

Following the usual approach we can define the sample autocovariance C_t (also the auto-correlation r) for $\{X\}$. Then it can be shown that there exist linear functions F_t of C_t (also corresponding functions R_t of r) of a finite length h , such that, they are distributed asymptotic normal and for all positive integers

t, T such that $t, T, |t-T| \geq h$, F_t and F_T (similarly R_t and R_T) are uncorrelated and therefore independent. Thus the squares of these functions can be used to provide χ^2 quantities for testing the goodness of fit of the model.

It can also be noted that the same sequence of auto-covariances for the scheme $\{X_t\}$ also gives rise to a corresponding linear process $\{X'_t\}$ of a generalised auto-regressive form. But it is shown that the test criterion available for $\{X'_t\}$ differs from the test developed for $\{X_t\}$ as these depend on the scaling factor, the variance of F_t (similarly of R_t). Thus even for the same set of auto-covariances it is possible to distinguish between the non-linear $\{X_t\}$ and the associated linear stationary scheme $\{X'_t\}$ as the non-linearity is reflected in the test criteria proposed.

This result can be generalised by removing the restrictions on the nature of the roots of the auxiliary equation. The corresponding results that have also been completely worked out involve slight modifications in the procedure and also in the form of derived test criterion.

7. Non-parametric tests for symmetry of multi-variate distributions.

J. ROY, Calcutta.

Non-parametric tests are derived for the hypothesis that the joint probability density function of a multivariate distribution is invariant under permutations (a) when location parameters are known and (b) when these are unknown. These may be regarded as non-parametric generalisations of Wilks L_{mve} and L_{rc} tests appropriate for multivariate normal distributions.

8. Asymptotic Power of certain test criteria.

A. R. KAMAT and Y. S. SATHE, Poona.

Let s^2 be the sample variance, δ^2 the mean square successive difference and d the mean successive difference; and let $\omega^2 = \delta^2/s^2$ and $W = d/s$. The statistics ω^2 and W have been proposed for testing the serial independence of successive observations by Von Neumann and one of the present author respectively. It has been shown by T. W. Anderson that for a certain class of correlated alternatives ω^2 may be considered the most powerful criterion. In this paper the asymptotic powers of ω^2 and W are investigated for another class of correlated alternatives. It is found that ω^2 is considerably more powerful than W for this class of alternatives.

Design and Analysis of Experiments

9. On a Generalisation of the Kronecker Product Designs.

B. V. SHAH, Bombay.

The use of incomplete block designs for estimating and judging the significance of the difference of treatment effects is now standard. Fisher and Yates have provided a complete table of balanced incomplete block designs (BIB) for values of $r, k \geq 10$. In this paper a method of constructing a special class of partially balanced incomplete block designs (PBIB) from the known BIB designs is given. Vartak and Sillito have used the Kronecker product of matrices to construct statistical designs. Their method and the method given in this paper differ only in the fact that in their method two distinct elements of a matrix are replaced by two distinct matrices, while

in the method considered in this paper, two or more distinct elements of a matrix are replaced by different matrices. All the PBIB designs considered in this paper are with three associate classes and the rectangular association scheme for $v=pq$ treatments written in p rows and q columns so that treatments in the same row are the first associates, treatments in the same column are the second associates and the rest are the third associates.

APPLIED STATISTICS

Economic Statistics

10. Index Numbers of Foreign Trade.

J. B. D. DERKSEN, Netherlands.

Index numbers of volume and unit value of foreign trade play an important role in the analysis of fluctuations in the foreign exchange position. In under-developed countries, imports often show rapid changes in composition, as a result of changes in plan requirements, the establishment of new domestic industries, the introduction of import restrictions on finished consumer goods, etc. The paper examines some of the technical problems arising in the compilation of index numbers of exports and imports. Annual index numbers of unit value should be derived by means of chained index numbers using moving cross weights ("ideal" index numbers). These computations may be carried out for total imports and exports and for commodity groups. In general, annual index numbers of volume should not be computed by means of the "ideal" index number formula, but by dividing value figures by the index of unit value.

To reduce the computational work load, monthly index numbers of volume and unit value may be derived by means of Laspeyre's formula, using as fixed weights the data for the preceding year. After computation of the annual index numbers, the monthly data may be adjusted, if necessary.

Comments are made on the problem of measuring changes in the terms of trade, as well as on the integration of the index numbers of foreign trade into a system of national accounts expressed in constant prices.

11. Accelerator Theory in Education.

STEN A. O. THORE and S. KRISHNA MOORTHY, Calcutta.

The problem considered in this paper is the following: "At what optimal rate and in what optimal pattern should education investments be stepped up in a country striving for economic development?" National income Y is the product of all productive processes in the country. The factors of production are labour L and capital K . Expenditure on education can evidently be considered as *investment in labour* L which will enable the factor of production L to generate more income. The authors suggest that it is possible to build up a theory of investment in labour that is similar to the theory of investment in capital. Just as in capital theory the investment goods industries are described as *deeper* than consumer goods industries, one can say that labour is *deeper* the more skilled and educated the workman is. Investment means deepening. Education is deepening of labour. The following six types of labour of different depths can be easily distinguished: (1) illiterate persons, (2) nursery and primary schools, (3) secondary schools, (4) colleges—intermediate classes, (5) colleges—B.A., B.Sc. classes, (6) colleges—M.A., M.Sc., research.

The principle of acceleration in capital theory says that if the demand for consumption goods increases by say 10%, then more capital goods will be needed

to bring forth this increase, and the construction of investment goods will have to be increased by more than 10%, say 50% or 100%. In a similar way, let us suppose that it is desired to expand education in a country and that one wants to increase the annual output of persons with nursery and primary school education by 10%. Then many new teachers will be needed to bring forth this increase, and the annual output of persons with *secondary* education—the depth level of primary school teachers—has to be increased by *more* than 10%. So we see that the acceleration principle in education means that the output of new labour on *deeper* levels has to be expanded at a *faster* rate than would be necessary in long-run equilibrium. In the dynamic up-swing the national production of teachers and instructors has to be accelerated at a speed that is proportional to the *rate of increase* of the desired number of pupils in schools.

The paper gives an empirical demonstration of the acceleration principle in labour theory on the basis of available data on the number of pupils and expenditure incurred in India during the past few years. The numerical values of the accelerator coefficients are estimated. The education targets of the Second Five Year Plan are analysed with a view to see whether the plan framers have recognised the significance of the acceleration principle in education and given due importance to the schooling of deep labour.

Sample Surveys

12. On Multi-phase Sampling.

R. P. BHARGAVA, Dehra Dun.

In this paper, for a p-variate normal distribution, expressions for the maximum likelihood estimate of the mean of the k^{th} phase variate x_k ($=2, 3 \dots p$) is obtained when the sampling is multi-phase and at random. The variance of the estimate of mean is expressed as a function of the population parameters, maximum likelihood estimates of each one of which is determined. Thus the best estimate of the variance is made available. Its large-sample first approximation is indicated. Some special cases are discussed. In the process of deriving these results the maximum likelihood estimates of the parameters of a p-variate normal distribution when the data are incomplete and of the multi-phase type are obtained.

When the sample is large and regressions linear, expressions for the estimate of mean of the last-phase variate and for its variance are derived without making any assumptions as to the form of the parent population for some special cases. Some of these cases are applicable to problems of sampling on successive occasions.

13. Sampling Error of the Regression Estimate when the Population is Finite.

M. V. JAMBUNATHAN, Mysore.

Let y be the principal character having mean $\bar{Y}$ and variance σ^2 in the population, and let x be an auxiliary character with known mean $\bar{x}$ and having correlation ρ with y . If a random sample of size n is drawn, the estimate of $\bar{Y}$ is given by

$$\bar{Y}' = \bar{y} + b(\bar{X} - \bar{x})$$

where $\bar{x}$, $\bar{y}$ are the means of x and y respectively in the sample, and b is the estimate of the regression of y on x based on the same sample. The estimate of the mean of y has variance

$$V(\bar{Y}') = \sigma_e^2 \left\{ \frac{1}{n} + \frac{(\bar{X} - \bar{x})^2}{\sum (x - \bar{x})^2} \right\}$$

the summation extending over all the n sample elements, and $\sigma_0^2 = \sigma^2 (1 - \rho^2)$ = the residual variance of y . The second term inside the braces of the above expression is the contribution to the variance on account of the regression itself being estimated, and the average value of this term in samples of size n is $1/n(n-3)$. When the sample is drawn from a finite population of size N , the function estimating Y is the same as above, but the variance of estimate is now given by the expression

$$S_0^2 \left\{ \left(\frac{1}{n} - \frac{1}{N} \right) + \frac{N (X - \bar{x})^2}{(N-1) \sum (x - \bar{x})^2} \right\},$$

where S_0^2 is the residual mean square and the summation is over all the n values in the sample. It is shown in this paper that the last term inside the braces occurring in the above expression has average value $1/(n-3) - 1/(N-3)$ in random samples of size n . The final expression for the variance of the estimate in this case has the average value (correct to second order of small quantities) given by the expression

$$S_0^2 \left\{ \left(\frac{1}{n} - \frac{1}{N} \right) \left(1 + \frac{1}{n} - \frac{1}{N} \right) \right\}$$

14. Measurement of Attrition in Technical Education.

K. C. SEAL, New Delhi.

The existing shortage of technical manpower can be partially met by reducing the wastage during the training period of the students admitted for technical training. For proper assessment of attrition during the course of training a detailed cohort study following each student throughout his training period is really required. Such a study for every training institution in the country (unless the total number of such institution are very few) will be a formidable task since, mere collection of such detailed statistics for a number of years about each student admitted in any institution, will be extremely difficult and time-consuming. It is indicated in the present paper how under some realistic model certain broad conclusions regarding wastage can be arrived at from the usually available data for most of the institutions such as (i) total number of admissions each year, (ii) total number of students appearing at the qualifying examination every year and (iii) total number of students qualifying every year.

As for instance, it is shown from an analysis of the available material on (i) and (iii) only that for medical graduates about 90% of the students admitted qualify in about 7 years' time instead of the usual duration of $5\frac{1}{2}$ years. Other examples are also provided.

Section III, Physics

1. On Solutions of He^3 and He^4 : Part II.

S. K. TRIKHA, Delhi.

Recently a theory of He^3 and He^4 solutions has been developed by Trikha and Nanda [Prog. Theor. Phys. 17 (1957), 679], referred to as Part I. On the basis of the theory we have discussed the osmotic pressure, the fountain effect and the heat resistance in He^3 and He^4 solutions. Theory and experiment are found to be in agreement in this case.

Fairly good agreement for the velocity of second sound and the effective "normal fluid" density in solution is obtained, on the basis of this theory, if we assume that

(i) He^3 atoms partake in the motion of the normal part particles, and (ii) the effective mass of the He^3 atoms in solution is twice the actual mass.

The basic assumptions on which the present theory is based are also discussed.

2. Photoelectric study of intensity variations of forbidden oxygen lines in the Airglow.

M. C. PANDE, Naini Tal.

A photoelectric study using narrow band filters of the variations of the 5577A and 6300A night airglow radiations was made during the I.G.Y. period for a region of sky near the Celestial Pole. A filter centered on 5300 A measured the continuum. The ratio of intensities at 5577 A and 5300 A, increased often during periods of enhanced solar activity.

On some nights a maximum of intensity of 5577 A was observed within a period of an hour or two after midnight.

3. Colour variation of the star Rho Puppis.

N. B. SANWAL, Naini Tal.

The dwarf cepheid Rho Puppis, which has an amplitude of light variation of 0.15 magnitudes in a period of 3 hrs. 23 m., has been studied photoelectrically. Observations of the spectrum by many investigators have shown no changes in its appearance at all, indicating that during a cycle no visible change of excitation temperature can be detected. Colour measures over a base line of 2000 A with narrow band filters indicate a colour variation of 0.10 magnitude. This indicates a variation of colour temperature of 350 degrees assuming the mean spectral type of the star to be F6 II. The range in temperature observed is too small to give noticeable change in the absorption line spectrum.

4. Influence of Sunspot Cycle on the Cyclonic Storm Tracks over the Bay of Bengal during the North-east Monsoon Season.

PRABHAT K. SEN GUPTA, New Delhi.

The tracks of cyclonic storms moving across the Bay of Bengal during the northeast monsoon season for the period 1905-1949 have been found to reveal the following characteristics indicating an influence of the solar cycle:—

- (i) With the approach of sunspot minimum a westward movement of these storms across the south Bay of Bengal with a tendency to strike the eastern coast of Tamilnad (present Madras State) becomes a common feature.
- (ii) During the maximum phases of the sunspot cycle westward tracks are fewer and recurvatures towards the north or northeast become more frequent with the result that fewer storms strike the eastern coast of Tamilnad.
- (iii) More cyclonic storms are seen over the Bay of Bengal during the minimum phases than during the maximum phases of the solar cycle.

These variations are attributed to periodic latitudinal shifts of the upper atmospheric pressure and wind systems in the steering layers in association with the sunspot cycle.

The effect of these variations on the rainfall of Tamilnad is manifested as a 'regular recurrence of more frequent excess rainfall days during sunspot minimum phases with intervening periods of subnormal rainfall'.

5. Some Aspects of the Bay of Bengal Waters.

C. POORNACHANDRA RAO, Madras.

The results of some of the author's studies on the physical oceanography of the Bay of Bengal waters off the east coast of India between the latitudes 13°N and 18°N are presented. The different aspects covered are the diurnal and seasonal variation of oceanographic and meteorological factors, water masses, ocean currents and the influence of river discharges on the sea water. Some of the main features are : the influence of surface wind on the diurnal variation of temperature of air over sea, the dependence of coastal wind variation (land and sea breezes) on the temperature contrast between sea temperature and coastal air temperature, the three layer structure of the thermosphere caused by insolation and sinking of denser waters formed due to evaporation/night cooling, the semi-diurnal oscillation of the isotherms in the thermocline and its relation to tide, the dependence of the diurnal variation of salinity on evaporation and tide, the coastal sinking and upwelling processes during the year, the dependence of the seasonal variation of salinity of the coastal waters on the wind component parallel to the coast and its relation to the accumulated rainfall, the presence of Indian equatorial water, Indian Central water and Red Sea water as deep water masses (in the top 500 metres layer under study), the alternating weak and strong ocean currents parallel to the coast (in the 180 km. zone off Visakhapatnam) and the three layer structure of the vertical salinity variation brought about by the river discharges into the sea.

6. $\text{O}^{16}(\text{d},\text{p})\text{O}^{17}$ in the Collective Model.

R. K. BANSAL, Bombay.

The absolute magnitude and angular variation of the differential cross-sections of the reaction $\text{O}^{16}(\text{d},\text{p})\text{O}^{17}$ for 9 Mev deuterons have been calculated by applying the shell model and the collective model of the nuclear structure. The shell model gives cross-sections which are many times the experimental value. In the collective model these are reduced by about 60%.

7. Conduction of Electricity through Metals and Superconductivity.

SIVA SADHAN BHATTACHARJEE, Silchar.

From the consideration of the energy content of the surface and the interior of a metallic specimen and the geometrical relation between the volume and surface and the electrical double layer like structure of the surface, it is shown that irrespective of its state a metal is built up of associations, hereinafter called metallic domains, of a particular size at a particular temperature. The free electrons at the surface of these domains are shown to be the major contributors of the electronic specific heat and the metallic conduction takes place through the agency of these electrons. They are accelerated by the external field and the surplus of energy is discharged as heat while they advance from one domain to another, the process being imagined to be analogous to the charging and discharging of electric condenser's. The electric double layer of the domain gives rise to capacity and hence the justification of condenserlike behaviour. The specific resistance is expressed as a linear function of the specific volumes. The order of magnitude of resistivity so obtained tallies with the experimental values. Next the Hall effect is considered and it is shown that the sign of the Hall constant depends on the shape of the domains and may be both positive and negative. The order of magnitude of the constant so obtained tallies with experimental values. The question of increase of

resistivity in the low temperature region exhibited by certain metals is also considered.

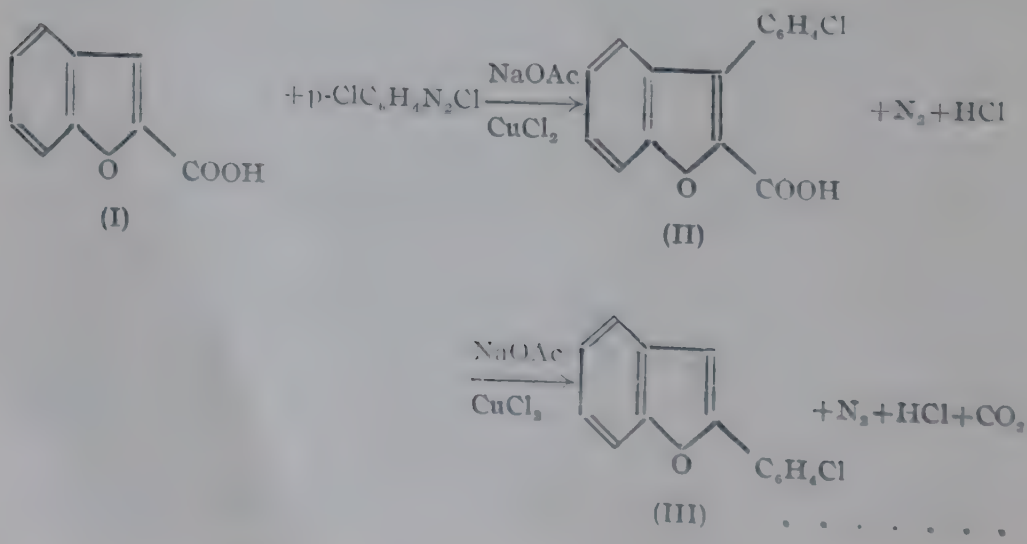
The expression of specific resistance developed here indicates directly the case of vanishing of the resistivity. As the volume decreases with temperature up to certain limit it is shown that the potential of the conduction electron suddenly becomes zero and so the superconductive transition takes place abruptly. The general equation of transition has been developed from the thermo-dynamic point of view. From the thermodynamic equation of transition the variation of entropy with transition, variation of critical field with temperature, latent heat of transition, specific heat of super-conductions, variations of domain size below the transition point, variation of magnetic susceptibility of super-conductors with temperature and Meissner effect etc. has been discussed in brief. As regards the thermal conductivity, it is the function ΔK —the difference between the conductivity between the two states that has been considered and shown to be a function of critical field and domain size etc. If the immediate neighbourhood of the transition temperature be excluded it is shown that $\Delta K = \theta_1 H_c d H_c d_1 \theta_2$, where H_c critical field temperature, θ_1 and θ_2 are constants. According to the present picture the superconductive transition changes the whole specimen into a single domain covered by an electronic sheath and thus Meissner effect is explained.

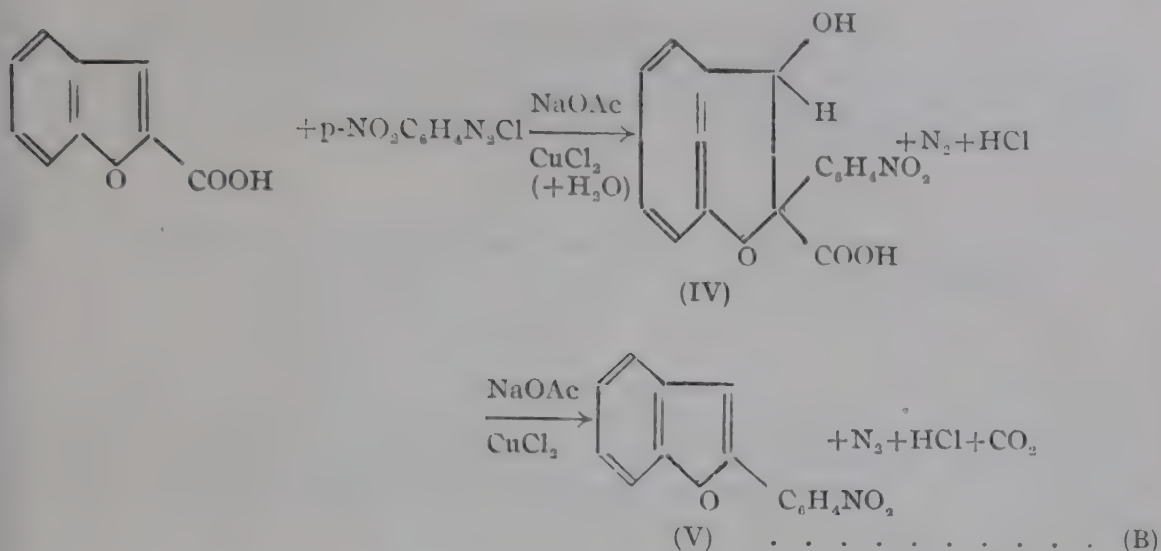
Section IV, Chemistry

1. A Study of the Meerwein's Diazo Reaction with Coumarilic acid.

K. B. L. MATHUR and H. S. MEHRA, Delhi.

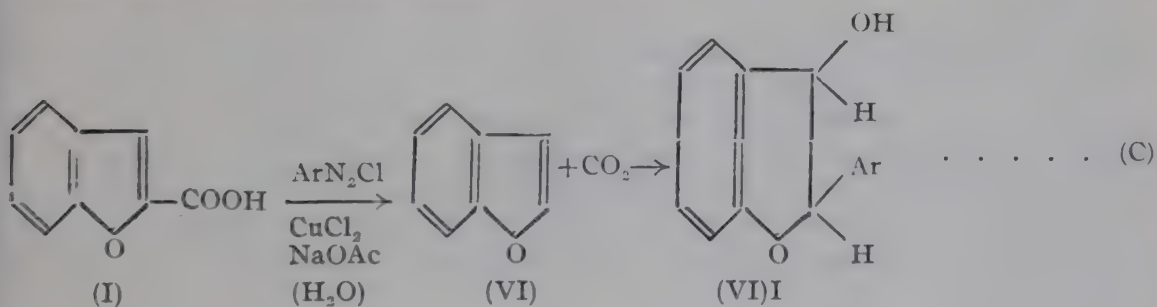
Coupling reactions with Coumarilic acid (I) have been studied with two of the reactive diazotised bases viz., p-Chloro-, and p-Nitrobenzene diazonium chlorides. p-Chlorobenzene diazonium chloride when reacted under Meerwein's conditions (cf. Meerwein, Buchner and Emster., J. prakt. Chem., 1939, 152, 237) with the above acid (I) gives 3-p-chlorophenyl coumarilic acid, $C_{15}H_9O_3Cl$, m.p. 254° (II) as well as traces of 2-p-chlorophenyl benzofuran (III). On the other hand, with p-nitrobenzene diazonium chloride, there result an acid, $C_{15}H_{11}O_6N$ m.p. 235° , considered to be 2-p-nitrophenyl-3-hydroxy dihydro coumarilic acid (IV) and a fair amount of 2-p-nitrophenyl benzofuran, $C_{14}H_9O_3N$, m.p. 184° (V). No analogue of (II) is found to be present in the reaction mixture.





There thus result two sets of coupling products involving arylation at the (3) and (2) positions in coumarilic acid—the actual position predominantly effected seems to depend on the nature of the diazotised base.

In the reaction with both of the diazotised bases, considerable decarboxylation without arylation also takes place. The benzofuran (VI) that may result in this way is taken, in the respective cases, to give rise to 2-p-chlorophenyl coumaran-2-ol, $C_{14}H_{11}OCl$, m.p. 124° (VII, $\text{Ar}=\text{p-ClC}_6\text{H}_4$ -) and 2-p-nitrophenyl coumaran-2-ol, $C_{14}H_{11}O_4N$, m.p. 122° (VII, $\text{Ar}=\text{p-NO}_2\text{C}_6\text{H}_4$ -) that have also been isolated from the reaction mixture.



The identity of the acid (III) and the furan (V) have been established by synthesis.

2. Studies on the Preparation of Milk Powder from Vegetable sources.

N. L. LAHIRY, Mysore.

The need to augment the existing resources of protein foods has been increasingly felt in recent years in our country. The utilization of certain oil-bearing seeds after suitable processing was stressed by numerous workers. Among these, groundnut, soyabean and to a lesser degree, cashewnut and almond, received due attention, and are at present processed to aid as supplements in the form of milks and curd. It is, however, felt that preparation of these milks in powder form easy to reconstitute in water, would offer ready and quick utilization of these products. In the present investigation, groundnut, sesame, soyabean, cashewnut and almond were blended in proper proportions and the milks obtained are dried using a drum drier or a spray drier. As presence of sesame seeds in the raw material was found to leave a bitter after-taste, sesame was omitted in the subsequent trials. The dried powder obtained by using groundnut, soyabean, cashew-

nut and almond kernels has been found to possess good flavour and texture and solubility characteristics. It has a protein content varying from 40—46 per cent. Further work bearing on the keeping quality and nutritional status of the material is under investigation.

3. Quantitative estimation of Ammines and Pyridine in mixtures and in presence of alcohols and phenols by thermometric titration.

B. C. HALDAR and R. D. DAFTARY, Ahmedabad.

In continuation with our previous work on the quantitative estimation of ethylene diamine, pyridine and aniline by thermometric titrations with acids such as hydrochloric, sulphuric, and nitric, it has been found possible to estimate quantitatively 4.57×10^{-4} gm/cc. of diethylamine and 6.82×10^{-4} gm/cc. of meta-amino phenol with an accuracy better than ± 1 per cent.

It has been observed that the presence of different concentrations of ethyl alcohol, iso-propyl alcohol and phenol has no interfering effect in the quantitative estimation of the above amines and pyridine.

The constituents of the mixtures (1) ethylene diamine and aniline or pyridine and (2) diethyl amine and pyridine or aniline, can be estimated quantitatively from their thermometric titration curves with HCl. The titration curve in each case indicates two breaks. From the first break the concentration of ethylene diamine or diethyl amine and from the second break the total concentration of the two constituents can be determined. Hence by subtraction the concentration of pyridine or aniline can be obtained.

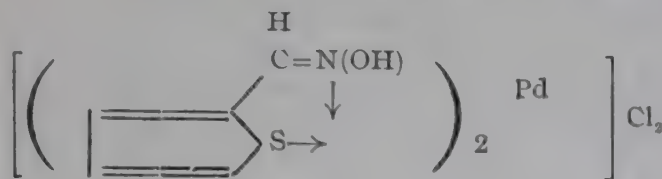
Pyridine, aniline and ethylene diamine or diethyl amine in a mixture can be estimated quantitatively by performing two titrations. The first titration with HCl gives two breaks. The first and second breaks indicate the concentration of ethylene diamine or diethyl amine and the total concentration of all the three constituents respectively. The second titration with sodium nitrite solution gives only one break from which the concentration of aniline can be found. Hence by subtracting the concentrations of ethylene diamine or diethyl amine and aniline from the total concentration of the three constituents, the concentration of pyridine can be obtained.

4. Thiophene derivatives as analytical reagents.

S. G. TANDON and S. C. BHATTACHARYYA, Poona.

2-thiophene-anti-aldoxime has been found to be a highly selective reagent for palladium forming with it in acidic solutions a light yellow, insoluble co-ordination complex of definite composition, suitable for qualitative detection, gravimetric estimation and separation of this metal from most other metals. 2-thiophene-anti-aldoxime is stable toward heat, light and air and can be preserved indefinitely either as such or in solution. Its solubility in cold water is enough to avoid any danger of the contamination of the palladium precipitate with excess of reagent. The palladium complex too is very stable. It can be digested in the acidic medium on a boiling water bath and is easy to filter. The precipitation of palladium is not conditioned by close control of pH because it takes place quantitatively from fairly strong acid solutions; this constitutes a distinct advantage, for palladium can be estimated in presence of many diverse ions without recourse to complexing agents for keeping them in solution. The complex has a fairly large molecular weight with a palladium factor of 0.2470 as against 0.3167 for dimethyl glyoxime, 0.2743 for noxime, 0.2669 for β -furfuraldoxime and 0.2009 for 3-hydroxy-1, 3-diphenyl

triazine. The palladium complex corresponds to the formulae $[\text{Pd}(\text{C}_3\text{H}_3\text{NOS})_2] \text{Cl}_2$. On the basis of data thus far collected it can tentatively be represented as a co-ordination complex as shown below: This structure has been arrived at from infra-red studies.



5. Studies on the noninterference of Ni^{+2} , Co^{+2} , Bi^{+3} , etc. in the Polarographic determination of Cadmium by Potassium Ferrocynide in citrate buffers.

N. A. RAMAIAH and H. C. SARASWAT, Kanpur.

The mechanism to elucidate the earlier observation (Proc. Ind. Sci. Cong. 1958) that Ni, Co, Bi, etc. did not interfere in the amperometric determination of cadmium with potassium ferrocynide in citrate buffers was examined polarographically from the standpoint of the formation of stable citrate complexes of Co, Ni, Bi, etc., vis-a-vis the unstable cadmium citrate complex. In KCl solution, the former ions were not reduced up to -2 volts, while the half wave potential of Cd^{+2} not altered in presence or on addition of potassium citrate.

6. Drug resistance in yeast.

T. R. SHARMA and J. P. SHUKLA, Kanpur.

Effect of cetyl pyridinium bromide (Fixanol, a cationic detergent) and sodium dodecyl naphthalene sulphate (Cerfak, an anionic detergent) on *Saccharomyces cerevisiae* (I.I.S.T. No. 13) was investigated. Beyond a certain concentration and just below the lethal doses, the two surface active agents gave rise to Primary and Secondary colonies where the strain was plated on agar medium containing appropriate concentrations of the inhibitors. On comparison with the parent strain, the secondary colony cells reflected an injury to the respiratory mechanism in as much as they showed a higher oxygen uptake and lower CO_2 evolution. The primary colony compared favourably with the parent strain. Further characteristic differentiations are being investigated.

7. Chemical Processing of Radioisotopes at the Atomic Energy Establishment, Trombay.

V. K. IYA and R. G. DESHPANDE, Bombay.

Isotope production in India is at present carried out in the Apsara reactor, where a neutron flux of about 1.7×10^{11} n/cm²/sec. is usually available at the core at a power level of 100 KW. This paper describes the general physico-chemical principles underlined in isotope production and the methods of production of various medically important radioisotopes like Phosphorus-32, Sulphur-35, Chromium-51, Iodine-131, and Cobalt-58, which are now being processed at this Establishment. A new method developed for the extraction of carrier-free Sulphur-35 from irradiated Potassium Chloride is described. The supply position of various radioisotopes from AEE T is also indicated.

8. Viscosity—Molecular Weight relationship of Poly 2-Vinyl Pyridine.

BIMAL BANDHU MUKHERJEE, Calcutta.

The paper reports the osmotic-molecular weight and intrinsic viscosity of poly 2-vinyl pyridine fractions in three solvents viz., methyl ethyl ketone and chloroform and alcohol. From these data the parameters of the modified staudinger equation have been calculated from the equation $[\eta] = KM\alpha \dots (1)$. The results are in agreement with the work of Fuoss and Strauss on poly 4-vinyl pyridine in alcohol, and has concurrence with the viscosity data in chloroform of poly-2-vinyl pyridine by Katchalsky, Israel. The results of the present author have given a better representation of experimental data in the recently developed Palit's equation connecting η with M (molecular weight) which is

$$100 \rho_0 \eta + \ln M = K_1 M^{2/3} + K_2 \dots \dots \dots (2)$$

where ρ_0 = partial density, K_1 and K_2 are constants, calculated from Slope and intercept respectively.

The values K and	α in the equation (1)
$\cdot 4365 \times 10^{-5}$	$\cdot 65$ for Alcohol
$\cdot 1778 \times 10^{-4}$	$\cdot 8$ for Methyl ethyl ketone
$\cdot 1023 \times 10^{-4}$	$\cdot 96$ for Chloroform.
The values K_1 and	K_2 in the equation (2)
$4 \cdot 14 \times 10^{-2}$	$2 \cdot 54$ for Alcohol
$1 \cdot 09 \times 10^{-2}$	$-4 \cdot 13$ for Methyl ethyl ketone
$5 \cdot 5 \times 10^{-2}$	$-54 \cdot 5$ for Chloroform.

Section VI, Botany

1. Recurrence of drought conditions and mortality in Sal forests of Uttar Pradesh.

A. C. GUPTA, Dehra Dun.

Drought has been a serious menace to the sal forests of Uttar Pradesh, the immediate effects of which are often imperceptible. If the drought conditions occur in successive years, the damage assumes a severe magnitude and extends far and wide. This affects the growth and reproductive capacity of sal forests to a varying extent. The young plants of sal, on which depends the perpetuity of the existing sal forests received the first and severest blow. Thousands of sal trees have died from time to time in sal forests of Uttar Pradesh, necessitating special fellings. In some areas the mortality of sal had been so extensive that an almost retrogression to a dry miscellaneous forest has occurred. Drought mortality seems to have a direct correlation with rainfall and the depth of the water table. The main role of drought conditions and ultimate mortality in sal forests lies in adversely affecting the soil moisture regime. Nature does help the forest in some areas to recover rapidly from its bad effects, especially if the drought year is followed by a good rainfall. Man's efforts in combating this menace lie primarily in practising successful fire protection and controlled grazing.

2. The genus *Synchytrium* of Bombay State.

S. D. PATIL and T. S. MAHABALE, Poona.

The paper gives an account of the genus *Synchytrium* in the Bombay State. Only one member of this genus was described by Patel *et al* (1949) previously.

Later three species on *Phaseolus mungo* Linn. *Blepharis asperrima* Nees, *Asystasia delzelliana* Sant. and *Lepidagathis trinervis* Wall. were reported by Payak (1951, 53). Two of these were new.

In the present investigation seventeen species of this genus were found on thirty-one different host plants occurring in the Bombay State. Two of these belong to the sub-genus *Woroninella*, eleven to the sub-genus *Mesochytrium* and four to the sub-genus *Pycnochytrium*.

Two species belonging to the sub-genus *Woroninella*, namely, *S. atylosiae* (Petch.) Gaumann on *Rhynchosia minima* DC. and other on *Cylista scariosa* Roxb. are described in detail. The former is a new record for this region and the latter seems to be a new species.

In the sub-genus *Mesochytrium* eleven species on twenty-one host plants are described with illustrations. Of these *S. lepidagathidis* Mund. & Mhatre and *S. rytxii* Syd. are very common, and occur on a number of host plants. All these eleven species and their twenty-one hosts are being reported for the first time from the Bombay State. Of these eleven species, five are probably new. The host of *S. alysicarpi* Ramk. and Sund., *Alysicarpus tetragonolobus* Edgew., constitutes a new host record, and also *Anisomeles hyncana* Benth. for *S. crotolariae*, Ramk. T. S. and K. They furnish additional information as regards the host of these species.

The sub-genus *Pycnochytrium* is represented by four species on seven host plants. *S. ajnekari* Payak and Thirum. was first described by Payak (1951). Here it is reported from one more host plant. *S. Khandalensis* Payak and Thirum. was found to be occurring on three different hosts of which one is a new host record, viz. *Eranthemum roseum* (Vahl.) R. Br. This species is characterised by articulated thickenings of the resting spore wall. The two other species of this sub-genus were found on *Hemigraphis latebrosa* Nees and on *Tragia involucrata* Linn. They are probably new.

3. Chromosome studies in two Himalayan species of *Polygonatum*.

VIRENDRA KUMAR, Delhi.

The Liliaceous genus *Polygonatum* belongs to the tribe Polygonateae, the present species *Polygonatum cirrifolium*, Royle, and *Polygonatum verticillatum*, Allioni, fall in group Verticillata. The taxonomical relationship among various species of this group are not well established. Cytological data can be of some help to elucidate the true relationship among species. Since the centre of diversification of this group is believed to be in Eastern Asia, studies on Himalayan forms can provide some valuable cytological information. Five different clones from Simla and Narkanda (West Himalaya) were studied. The chromosome number and morphology were analysed from somatic root tip plates and haploid chromosome complement seen during generative nucleus division in colchicine treated pollen tubes.

In *Polygonatum cirrifolium* $2n=38$ and $n=19$ has been noted. The karyotype is asymmetrical with long, medium length chromosomes with subterminal primary constrictions and short chromosomes with subterminal and median constrictions. One pair of each of long and short chromosome shows the presence of secondary constrictions.

In *Polygonatum verticillatum*, four strains named S, N, H, and IIT, collected from different localities at different altitudes were studied. In general, the karyotype is on the same plan as in the earlier species *Polygonatum cirrifolium*, except for the presence of a pair or two of extra long chromosomes with submedian primary constriction. Following chromosome numbers were noted: Strain S:

2n 30; Strain N : 2n 30; Strain H : 2n 60 and 64; Strain HT : 2n 29 and 30. The plants belonging to strain HT are morphologically distinct from rest of the strains. The tetraploid plants show the external morphological characters associated with polyploids. In various strains in spite of constant chromosome number, complements are structurally heterozygous and the karyotype differs from one strain to another.

It seems that structural hybridity and polyploidy associated with vegetative reproduction accounts for, great morphological variation seen in different populations and also speciation in this group. A few more species and strain from Eastern Himalayas are under investigation.

Section VII, Zoology and Entomology

1. Preliminary observations on hybridisation of the common carp (*Cyprinus Carpio*) with Indian Carps.

K. H. ALIKUNHI and HIRALAL CHAUDHURI, Cuttack.

The Indian carps do not ordinarily breed in ponds, while the common carp *Cyprinus carpio* freely breeds in confined waters. Attempts were therefore made to cross selected Indian carps with the Common carp and thereby raise hybrids which might possibly combine the desirable qualities of the two parents.

Though the nature of the fertilised eggs and the period of incubation are widely different in Indian carps as compared to the Common carp, it was possible to successfully fertilise stripped eggs of *Labeo rohita* with the milt of *Cyprinus carpio*, hatch them and grow the young ones. Stripped eggs of *C. carpio* could repeatedly be fertilised with the milt of *Labeo rohita* but the young ones did not hatch out. The paper includes details of development of the hybrid and its characters.

2. Experiments on hybridisation of Indian Carps.

HIRALAL CHAUDHURI, Cuttack.

Successful breeding of the major Indian carps in confined waters by giving injections of pituitary gland hormones (Chaudhuri & Alikunhi '57) has made selective breeding of these fishes possible for raising new strains or hybrids having better cultural qualities. During the 1958 carp breeding season, cross breeding of the following Indian carps was successfully carried out by stripping the injected males and females and fertilising the eggs artificially.

Species : Male	Female
1. <i>Catla catla</i>	with <i>Labeo rohita</i>
2. <i>Catla catla</i>	with <i>Cirrhina mrigala</i>
3. <i>Catla catla</i>	with <i>Labeo calbasu</i>
4. <i>Labeo rohita</i>	with <i>Cirrhina mrigala</i>
5. <i>Labeo rohita</i>	with <i>Labeo calbasu</i>
6. <i>Cirrhina mrigala</i>	with <i>Labeo rohita</i>
7. <i>Cirrhina mrigala</i>	with <i>Labeo calbasu</i>
8. <i>Labeo calbasu</i>	with <i>Labeo rohita</i>
9. <i>Labeo bata</i>	with <i>Labeo rohita</i>
10. <i>Labeo bata</i>	with <i>Labeo calbasu</i>
11. <i>Cirrhina reba</i>	with <i>Labeo rohita</i>
12. <i>Cirrhina reba</i>	with <i>Labeo calbasu</i>

The fertilised eggs were hatched in trays and hapas and the hatchings reared in aquaria till the advanced fry stage when they were stocked in ponds for growth. The paper includes details of the characters of the various hybrids and their relative growth.

3. Macronucleus and ribonucleic acid in *Tetrahymena pyriformis*.

C. M. S. DASS, Delhi.

Nature of the changes occurring in the macronucleus of axinically grown cultures of *Tetrahymena pyriformis* during growth phase and division has been studied cytochemically. It is seen that the macronucleus is compact and intensely Feulgen positive at the beginning of growth phase. Staining reaction with Azure B and Gallocyanin coupled with Perchloric acid treatment indicated a gradual synthesis and accumulation of ribonucleic acid (RNA) in the macronucleus during growth period. Such a situation has also been recorded in several ciliates. With the initiation of binary fission indicated by the enlargement of the micronucleus, there is a complete loss of all macronuclear RNA. The significance of such a cyclical appearance of RNA in the macronucleus has been discussed in the present study.

4. A new type of life cycle in the Gregarine from the seminal vesicles of earthworm.

G. P. DATTA, Jullundur.

This type of life cycle is a connecting link between the Eugregarines and the Schizogregarines. It resembles Eugregarines in the absence of Schizogony and Schizogregarines in having a multinucleate trophozoite.

In the light of the observations made it appears that this Gregarine cannot be placed in any of the two existing suborders. A new suborder which will be a connecting link between the two existing suborders has to be created.

Further studies on the life history of the Gregarines with the application of special Nucleic Acid technique are very essential to confirm the classification of this group.

5. The Persistent Toxicity studies of DDT & BHC against Insect Pests of Stored Grains on different Storage Receptacles used in the Punjab : Relative Toxicity of Films.

B. S. DHILLON, Ludhiana.

Investigations to determine the optimum concentration of both DDT and BHC formulations were carried out in a small room under natural conditions. Representative surfaces of cement plaster, 'Pucca' (burnt) brick, 'Pucca' brick white-washed (lime deposit 625 mgs./sq. ft.), 'Kothi' (sun dried clay-mud), hessian and 'Theka' (indigenous coarse cotton cloth) were treated with 0.1, 0.5, 1.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5.0 per cent solutions, suspensions and emulsions of DDT and BHC, and exposed to the laboratory-bred test insects of known age for a period of three hours, after the dry residual films on them were four days old. The chemicals in measured quantities were sprayed on to the surfaces by means of 'Holmspray' throat atomizer.

The results, based on the mortality of the insects examined after 72 hours of 'recovery' period and being averages of three replicates as calculated by Abbott's

(1925) formula, showed that the optimum dosage for the control of *Rhizopertha dominica* F. ranged from 0.5 to 2.5% (deposit of toxic ingredient being 36-178 mgs./sq. ft.) in the case of DDT and from 0.5 to 1.0% (deposit 36-71 mgs./sq. ft.) with BHC depending upon the combination of formulation and the storage surface used. Such effective dosages of DDT and BHC for *Sitophilus oryzae* L. ranged from 2.5 to 3.0% (deposit 178-213 mgs./sq. ft.) and 1.0 to 2.5% (deposit 71-178 mgs./sq. ft.), respectively, while those for *Tribolium castaneum* Hbst. from 2.5 to 5.0% (deposit 178-356 mgs./sq. ft.) for both DDT and BHC. The grubs of *Trogoderma granarium* Everts remained immune to the toxic action of dry films from both 5% DDT and BHC even when the exposure period was continuously extended to 24 hours and also when both the deposit of toxic ingredients of the films was doubled (711 mgs./sq. ft) and the exposure period extended to 15 days. It was, however, noted that BHC in the latter treatment slightly induced the transformation of the grubs to pupal and adult stages. The adults of this pest were, however, found to be adequately susceptible to the toxic action of 5% DDT & BHC films.

Among the adults, *Tribolium* was more hardy than *Sitophilus*, which, in turn, was more resistant than *Rhizopertha* to the toxic action of the chemicals. *Rhizopertha* was more or less equally susceptible to the toxic action of both DDT and BHC, whereas *Sitophilus* was more susceptible to that of BHC and *Tribolium* slightly so to that of DDT. Of the various formulations tested, suspension proved more efficacious than emulsion, which, in turn, was superior to solution. The suitability of the storage surfaces in respect to the formation of efficient dry residual films was in the following descending order. 'Theka', hessian, 'Pucca' brick, cement plaster, 'Pucca' brick white-washed and 'Kothi'.

6. The Persistent Toxicity studies of DDT & BHC against Insect Pests of Stored Grains on different storage Receptacles used in the Punjab: Films formed in summer.

B. S. DHILLON, Ludhiana.

Studies on the duration of the periods for which residual films, left after the storage surfaces were sprayed in mid-April with 5 per cent DDT & BHC in solution, suspension and emulsion (deposit of toxic ingredient 355.5 mgs./sq. ft.), remained effective against the test insects, were made under natural conditions of storage. DDT films were more durable than BHC ones, the respective ages being in the ranges of 90-400 and 30-130 days. The actual age of a particular film was determined by the type of storage surface, formulation of insecticide and species of test insects used. Of all the beetles tested, *Tribolium castaneum* Hbst. proved to be the most resistant and was followed in descending order by *Sitophilus oryzae* L., *Trogoderma granarium* Everts, and *Rhizopertha dominica* F.

Amongst the formulations of both DDT and BHC, suspension was the first, emulsion second and solution third in position so far as persistence in toxicity of the insecticide films was concerned. The type of surface upon which the residual films were formed had little influence on the persistence of toxicity from BHC in general, and its suspension and emulsion in particular, but of the DDT-treated surfaces tested against the test insects, 'Pucca' (burnt) brick was found to be the best and was followed in descending order by hessian, cement plaster, 'Pucca' brick white-washed, 'Theka' (coarse cotton cloth), and 'Kothi' (sun dried clay-mud).

The environmental factors, mainly temperature and relative humidity, prevailing in the store seemed to exert their influence on the toxicity of the residual films, and their effect was pronounced in those cases, where either the species of the test insect was resistant or the insecticide film was weak or both combined.

7. Estimations of soil-arthropod populations : II. Extraction apparatus.

B. S. DHILLON, Ludhiana.

A brief review of the extraction methods, employed for large scale population surveys of soil arthropods has been made. In spite of some limitations—inherent in the desiccation method, popularly known as Tullgren funnel, it was favoured and used.

The apparatus consisted essentially of a framework, 24.1×20.5×20.0 in., constructed of L- & U- section aluminium girders supporting six batteries of Tullgren extraction units mounted side by side. Each battery of extraction unit is described in detail.

The following conclusions were arrived at. For the maximum emergence of the extractable test animals, Collembola and Acarina, a 10-day heating period was satisfactory. Considerably higher overall temperatures were attained in both the glass-plated and glass-plated plus gaps between baffles sealed versions of the apparatus than in the open-side one. Furthermore, there were considerable temperature differences between the outermost and intermediate soil cores as well as between the middle and centre ones, when the soil cores were divided into 3 imaginary circles. The differences were greater when the overall temperatures were high with the lamps in the lowest (1.9 cm.) position than those when the lamps were at the highest (9.7 cm.) position above the samples. Nevertheless, the differences in temperatures existing between the outer and central parts of the apparatus were not sufficient to have any effect on the efficiency of the extraction process.

Of the three temperature régimes compared, namely, *constant low*, *constant high* and *gradually increased*—the first proved superior to all in respect of the extraction of the fauna. The crumbling of soil sample for the extraction of the animals is likely to impede the emergence of, at least, the smallest and most delicate of the arthropods, perhaps owing to the rapid desiccation of the soil crumbs.

8. One of the easy and economical ways of destroying Desert Locust.

B. S. DHILLON, Ludhiana.

The locust invasion of the Punjab during 1954 was of unprecedented nature and the locust-fighting resources of the State were awfully strained. Along with the normal measures, protective bands of 10% BHC dust laid by means of power duster, 2.5 h.p. output capacity 160 pounds of dust per hour, mounted on a jeep, were also tried. The bands were put in advance at places over which the hoppers (nymphs) were likely to march to the crops. The technique consisted of directing the nozzle of the duster down to the ground and holding it about 3 inches above it so as to deposit a band of BHC dust about 6 inches wide, while running the jeep at a speed of 15 miles per hour. The assessment of the results was made after 12 hours of the operation in summer and after every week during winter.

In the experiment conducted in late August one pound of 10% BHC dust used in a 164 yard long band before a column of 3-4 instar hoppers extending over an area of 8 acres was as efficacious as 200 lbs. of 5% BHC dust used in direct dusting. In another experiment carried out on somewhat larger scale during winter, 18 pounds of 10% BHC dust deposited into four bands, total length being over 3000 yards, around and within a 31-acre village waste land area, proved as useful as 1530 pounds of 3.3% BHC dust used twice in directly dusting an equal area under gram crop infested by first-instar hoppers. The toxicity of 10% BHC dust against 3-4 instar hoppers lasted for about a week in summer whereas it persisted for over a month against the 1-2 instar hoppers in winter.

9. Observations on breeding of Major Carps in Madhya Pradesh.

G. P. DUBEY and R. P. TULI, Madhya Pradesh.

1951-58 Surveys have led to the establishment of 14 carp breeding grounds in the state, constituting 4 distinct categories as under :

1. River as Home and breeding in open fields.
2. Reservoir as "Home and breeding in open fields".
3. Breeding inside the E.T.L. margins of the reservoir.
4. Breeding in Dry-type of bundh after transplantation of brooders.

Various views have been expressed to account for the phenomenon of breeding of Indian Major carps. Since 1951-58, 44 cases of breeding have been observed and recorded by the authors.

The observations show that the carps breed in this part of the country with the onset of South-west monsoon from the end of June to the end of August. Carps breed on hard soils, grassy plots, soft sandy soils and even on stony embankment. Spawning occurs in 6" to 6' deep water; with alkaline pH 7.2-8.2; temperature range 25°-33°C. and the dissolved oxygen 4.6-6.8 ppm. The lunar periodicity has no correlation with spawning.

It may therefore be concluded that a normal mature fish shows complete acclimatisation with its organ systems functioning normally. The gonadeal cycle is controlled by pituitary and the gonads are ripe by the monsoon. pH of the rain water and dissolved chemicals activate the thyroid and induce spawning migration. The high O₂ content and low temperature provide optimum requisite for the accelerated metabolism which climaxes spawning of carp.

10. A contribution towards the study of fluctuations in Insect abundance of Pilani (Rajasthan).

B. B. GUPTA, Pilani.

A study of the general fluctuations in insect abundance of Pilani has been undertaken. It is noted that the insects are more in Summer than in Winter. The incidence of some of the insects bears a close relationship with the average Relative Humidity of the night. However, the phase of the moon plays an effective role in determining the incidence of nocturnal insects. During full moon nights the catches were always very low while during the dark nights they were very high. The fluctuations in incidence of certain insects were enormous ranging from a few to 2500 individuals per night. This type of work may help in determining the advent of a particular destructive nocturnal species.

11. Hyperplasy induced in the Salamander by Methylcholantrene.

S. IDELMAN, Pondicherry.

I. Subcutaneous injections of *Methylcholantrene* in pure olive oil were given to 10 Salamanders (*Salamandra masculosa*). On the 10th day a thickening developed at some points of the epithelium, above the regions where drop of injected solutions were present. These thickenings extended as ducts between the glands and pushed back the connective tissue. In about 30 to 40 days after injection, the maximum penetration was seen, the muscular layer was merely pushed and not penetrated by the duct. Furthermore, the ducts withdrew and disappeared completely by about the 80th day and the epithelium returned to normal condition. The controls injected with the olive oil without cancerigene carbide never showed

such a penetration. Therefore methylcholantrene induces regressive hyperplasy in the Salamander.

II. By injection of Infra-toxic doses of potassium cyanide together with carbide, the hyperplasy process is simply restricted. The cyanide, the poison of cellular oxidation, does not therefore induce any modification of this experimental hyperplasy. On the contrary, the dinitrophenol, poison of oxydative phosphorylation, seems to have a marked inhibitory action on this hyperplasy.

12. DDT resistance in house flies in Cantonments.

COL. N. D. P. KARANI and P. BALARAMA MENON, Poona.

Houseflies, *Musca domestica nebulosa* (Fabricius), from Poona Cantonment area were tested for their susceptibility to DDT and compared with a non-resistant strain of the same species maintained in the laboratory of the Armed Forces Medical College. It was seen that while a 2% concentration of DDT killed less than 50 per cent of flies from the cantonment area, a 100 per cent kill of the colony flies were obtained with a strength of 0.5% DDT. It thus appears that houseflies in Poona Cantonment area have developed a high degree of resistance to DDT. Studies are being continued.

13. The Circulatory System of *Natrix piscator piscator* (Schneider) Reptilia: Ophidia.

H. V. KASHYAP and S. R. VELANKAR, Visnagar.

The present study was prompted by the excellent account of the circulatory system of the common British grass snake, *Tropidonotus natrix* by O'Donoghue (1912) and the general paucity of such studies on the Indian reptiles. The heart is situated far back in the body and consists of two unequal auricles and a ventricle. The latter is incompletely divided by an interventricular septum. The cavum dorsale also shows a somewhat prominent and incomplete median vertical muscular ridge. Only the left carotid artery and the right pulmonary artery are present, the corresponding vessels of the opposite side being absent. The parietal arteries are numerous, unpaired and enter the body wall medially. There is an azygos vein on the right side. The hepatic and renal portal vessels are interconnected. Anterior abdominal vein is small and independent. The circulatory system conforms to the general ophidian pattern.

14. "A preliminary Fisheries Survey of Nagda Reservoir".

R. K. MEHRA, Gwalior.

Nagda reservoir is one of the best fishseed collection centres of Madhya Pradesh. The survey was undertaken at the time of Carp breeding in July 1958 and at the time of fry and fingerling collection in September and October, 1958. The reservoir is constructed by taking advantage of a small valley formed by the hilly terrain on the East and South and upland area on the West and North. There are two small dam walls and one waste weir. Submerged area at F.T.L. is of 856 acres and during summer it shrinks to its half. The reservoir is fed by one main Nagda stream and two small nalas, i.e. Bharka and Khari. A map giving the topographical and hydrological features of the reservoir is presented. Spawning beds of major carps, minor carps, murrels and cat-fishes have been

shown. Fingerling collection areas are also marked. One game fish i.e. Barbus (Tor) tor, 25 food fishes and 15 forage fishes have been recorded. Major carp constitute 90% of the catches during last five years. Fishing is done by cast, drag and gill-net operations.

15. The use of S/V Mosquito Control Oil as a larvicide.

P. BALARAMA MENON, Poona.

A standard-vacuum oil company product, S/V Mosquito Control Oil, was tested with malariol as a standard against mosquito larvae of both *Culex* and *Anopheles*. The tests were conducted for toxicity, spreading co-efficient and film stability. The methods adopted in these tests were as described by Herms and Gray (1944), keeping in view the specifications laid down by the Indian Standards Institution for mosquito larvicidal oils. The results of the tests indicate that:—

- (1) The S/V mosquito control oil possesses toxicity comparable to that of malariol both against Anopheline and culicine larvae though against the latter it appears to have a slower action.
- (2) It spreads easily on the surface of water, the spreading power being more than that of malariol and much more than that of castor oil (spreading coefficient 16-20 dynes/cm).
- (2) Film stability is less than that of malariol and the surface film of the oil tends to break up after an hour.

16. Type-locality and Distribution of Hamilton's Gangetic Fish *Cyprinus (Garra) lamta*.

A. G. K. MENON, Calcutta.

Great confusion has centred round the type-locality and the precise specific limits of *Garra lamta* (Ham.), the genotype of *Garra*. Hamilton's manuscript notes however, cast some light in conjunction with the same authors' original figure "*Cyprinus godiyari*" on the identity of his *Cyprinus lamta*. Both *godiyari* and *lamta* are local names of the same species in Bhagalpur and Gorakhpur districts respectively. Thus, it is evident that Hamilton included both the forms of the Bhagalpur and the Gorakhpur districts under his *Cyprinus lamta*.

Extensive ichthyological surveys of the Kharagpur Hills in Monghyr district (formerly included under the Bhagalpur district) and the Rapti drainage north of the Gorakhpur district in Nepal (formerly included under the Gorakhpur district) were made and the material thus collected were statistically analysed. The statistical analysis of these two populations showed beyond any doubt that the Kharagpur Hill form is taxonomically distinct from that of the Rapti form. Since Hamilton designated his first species of *Garra* as *Cyprinus lamta*, the trivial name being the local name for the fish in the Gorakhpur district "the Rapti River of the Gorakhpur District" is considered as the type-locality of *Garra lamta* and not the "rivulets with rocky bottom in the province of Bihar". The type-locality has further been restricted to the Butwal stream, a tributary of the Rapti river about 21 miles north of Nautanwa in Gorakhpur district. The Rapti river, in the present day Gorakhpur district, is a muddy channel and is not ecologically suited for hill stream fishes.

The range of distribution of *G. lamta* is from Darjeeling and Sikkim to Nepal and Kumaon along the Himalayas.

17. The effect of Trypan Blue on Chick embryos Cultured *in Vitro*.

LEELA MULHERKAR, Poona.

A series of malformations have been reported on rats and mice by administering the Vital dye trypan blue, to pregnant mothers. Waddington and Perry observed similar effects on amphibian embryos by administering the dye directly by dissolving it in the culture medium in which the embryos were maintained. In the present work the dye was administered directly to the chick embryos. A number of abnormalities were observed at the primitive streak stage and the medullary plate stage.

The abnormalities included shortening of the axis, malformation of the Somites, mesodermalization of the notochord and formation of large blisters between ectoderm and mesoderm.

It is concluded that the effects of Trypan blue on chick embryos is unspecific, the abnormalities being probably attributed to the general toxicity of the dye rather than to its specific effect on any particular tissue.

18. Effect of ribonuclease on shell regeneration in *Ariophanta* sp.

K. K. NAIR and P. T. MUTHE, Bombay.

It is supposed that the formation of the shell consists of two phases. During the first step there is the elaboration of a protein membrane and in the second, mineralisation of this membrane takes place. It has been shown earlier by one of us that ribonuclease inhibits the uptake of labelled calcium. In order to assess the role of RNA in shell regeneration, observations were made on the regenerating pieces of the shell of *Ariophanta* after injection of RNase (2 mg/0.5 ml.). Treatment with RNase brought about a 50% inhibition (dry weight/1 cm²) in shell regeneration. It is concluded that RNase, by inhibiting the synthesis of proteins which form an essential constituent of the shell, and also by preventing the binding of calcium ions at the surface of the amoebocytes which normally transport calcium ions to the area of repair, slows down the process of regeneration.

19. Delayed implantation in the rat induced by autografts of the hypophysis.

M. R. N. PRASAD and ROLAND K. MEYER, Bangalore and Wisconsin.

In the rats of the Holtzman and Sprague Dawley strains autografts of the pituitary gland placed under the kidney capsule approximately 24 hours after finding sperm in the vagina cause a delay of 1 to 20 days in implantation of embryos. Examination of embryos flushed from one uterine horn during the delay show that they are unilaminar blastocysts. Blastocysts were not recovered from the uteri of hypophysectomised rats and neither were implantation sites observed in such rats given estrone. Everett (1956) has shown that pituitary autographs continuously secrete luteotrophin which prolongs the functional life of the corpus luteum. On the basis of his observations it is suggested that the retention of the embryos in the viable unilaminar blastocyst stage in rats with pituitary autografts is due to progesterone from endogenous sources. Induction of implantation by small amounts of estrone confirms the results of Canivenc and Laffargue (1956) and Cochrane and Meyer (1957) who reported that in ovariectomised rats exogenous progesterone delays implantation and small amounts of estrone injected exogenously cause nidation. All efforts to induce delayed implantation in the Golden hamster have

failed. It appears that in the hamster the blastocysts implant in the presence of progesterone while they are not viable under conditions deficient in progesterone.

20. Abnormal behaviour of the male meiotic chromosomes in *Pocillocerus pictus* F. (Acridiidae).

M. D. L. SRIVASTAVA, Allahabad.

The spermatogonial metaphase plate of this grasshopper contains nineteen chromosomes, which fall into nine pairs (the autosomes) and an unpaired element (the x-chromosome). In most testicular lobes meiosis is normal. The early leptotene threads are completely despiralized and fresh spiralization sets in during late leptotene, so that the zygotene threads are already spiralised to some extent.

In some testicular lobes cysts in which meiosis is abnormal are observed. In such cases the pachytene threads become much more deeply stained than in normal spermatocytes, run together, and ultimately give rise to a structureless mass. More generally the abnormality sets in later. The first metaphase bivalents (or diakinetid bivalents) adhere closely to each other to form a chain or a lump; in such cases congression fails. The bivalents become more and more structureless and ultimately give rise to a mass of deeply-stained substance. Some spermatocytes, however, recover. The bivalents become orientated and anaphase gets under way. The separated chromosomes may still adhere to each other. During interphase the chromosomes are very much drawn out and twisted, which condition may persist up to the beginning of the second metaphase. The second meiotic division seems to be normal.

21. Studies on the insect fauna of Poona—Part I (Aquatic Heteroptera).

G. T. TONAPI, Poona.

Collection and identification of insect fauna of certain ecological habitats of Poona and adjoining areas have been undertaken with a view to determine their periodicity and bionomics. The paper gives results of spare time collection of aquatic heteroptera with notes on their habitats. Topographical and meteorological considerations are also included. It is note-worthy that many of these bugs e.g., *Gerris* (Gerriidae), *Rhagovelia* (Veliidae), *Hebrus* (Hebridae) etc. representing Gymnocerata and *Enithares* (Notonectidae), *Corixa* (Corixidae), *Laccotrephes* (Nepidae), *Sphaerodroma* (Belostomidae) etc. belonging to Cryptocerata show characteristic fluctuations. Attempts are made to correlate these fluctuations with meteorological conditions. Nearly 40 species belonging to 14 families are recorded; and some are new records from this area.

22. A Note on two abnormal *Rana tigrina* Daud.

G. T. TONAPI, Poona.

A deviation from the normal growth of paired limb occurs now and again throughout the vertebrate series and a brief account of the previous works on such anomalies in Amphibia is given in the paper. Attention is drawn to a recent report of an Abnormal *Rana tigrina* in which the right hind limb is totally missing. Two more cases of anomalipeds are reported. A complete description of the external features and some of the associated abnormalities in the muscular and skeletal system is provided. In one case the astragalus and calcaneum are stunted and conjoined with variation in the number and position of the phalanges. In the

second case there is a total absence of digits and tarsal bones. The astragalus and calcaneum are represented by ill-developed bones. In both the specimens there was no free articulation of the distal segments of the limbs in question. A significant morphological feature is the fact that right hind limb only is affected. Some of the causative factors responsible for the production of such freaks are discussed.

Section VIII, Anthropology & Archaeology

I. PHYSICAL ANTHROPOLOGY

1. Anthropometric study of Sansis of Delhi.

VIJENDER BHALLA and DARSHAN SINGH, Delhi.

The paper deals with the Anthropometric measurements of the Sansis—till recently a nomadic criminal tribe.

The Sansis are predominantly dolichocephalic with prominent nose ranging from Mesorrhini to Leptorrhini. They are medium statured, with a medium brown to dark-brown complexion. Their eye colour is dark brown. With such a cast of features the Sansis can best be affiliated to the mediterranean stock of Guha.

By comparison of Anthropometric measurements of Sansi settled in Delhi with the immigrant Sansis from Pakistan (Montgomery and Multan area), it has been found that the two groups belong to the same ethnic stock.

2. Co-relation of certain body measurements and vital capacity.

J. C. SHARMA, Gwalior.

The present study based on one hundred male students of the G. R. Medical College, Gwalior, is intended with a view to find out the bearing of certain body measurements on vital capacity. The measurements like, Standing-Height, Weight, Transverse Diameter of the Chest, Antro-post. Diameter of the chest, Chest Expansion, Body Surface Area and Max. Displacement of Diaphragm are considered. The body measurements were taken with an Anthropometer and the Diaphragm Displacement was measured with a Sliding Calipers, on an X-Ray Screen.

Vital Capacity was measured in litres with an ordinary Spirometer, three times and mean calculated there from.

The subjects belong to different Castes and Provinces of India and hence the Genetic potentialities effecting the vital capacity and the body measurements have not been taken into account in the present study.

The mean values with Standard Deviation, Coefficient of Variation and maximum and minimum values of the various body measurements have been recorded.

Six Correlations computed from the body measurements were selected that might reasonably be expected to bear some relationship with vital capacity. The purpose was to ascertain the effect of body dimensions on vital capacity and their extent to which they are responsible.

All the correlations are positive. The value of 'r' indicates a marked association in the case of correlation between body surface area ($r=0.9$ and $t=16.1$). The value of 't' for testing the significance of 'r' is highly significant in all the correlations based on the above mentioned measurements.

3. Fingerball patterns of the Panjabi-Khatris.

INDERA P. SINGH, Delhi.

Fingerprints of 150 persons—75 males and 75 females were studied in order to determine their racial position. The frequency of whorls, loops and arches among the Panjabi Khatris was 39.46, 56.60 and 3.93 respectively. The Panjabi Khatris were found to be similar in their W-L-A frequency to the Hindus and Sikhs of Northern India as well as some mediterranean groups. It was further noticed that about six per cent of the whorls were composites. Whorls were found to be most common on the 1st and 4th digits, while loops occurred more frequently on the 2nd, 3rd and 5th digits. Marked sex-differences were noticed, i.e. that whorls were more frequent on the fingers of males, while loops and arches abound more on the fingers of females. Considering bimanual differences we found that the whorls were more frequent on the fingers of right hands, while loops and arches were more common on the fingers of left hand.

Wilder had divided whorls into inner, meeting and outer on the basis of the radiant of the left delta meeting the radiant of the right or passing above or below it. The basis of dividing whorls was changed to avoid the anomaly that the same whorl is inner on the right hand but is outer if found on the left hand. The radiants were traced from the radian side in both the hand. A new terminology was also suggested, i.e. medial (inner), meeting and lateral (outer) to avoid any confusion. Lateral whorls were found to be most frequent. Medial whorls are found to be most common on the 2nd and 3rd digits.

II. SOCIAL ANTHROPOLOGY

4. The Culture-Linguistic Regions in India ; A case study—Bihar.

L. P. VIDYARTHI, Ranchi.

The main problem raised in this paper is : can we find a middle range unit of analysis in India between, an all India generalisation and a village level uniqueness? Search for such an approach to the study of Indian Civilization is considered essential as an all India approach leads us to generalisations and abstractions that are removed from 'realities' and the village level diversity obviously has little practical use. Such middle range units are discerned in fifteen culture-linguistic regions, determined on the basis of language and many other meaningful cultural variables. This culture-area approach has been demonstrated with the study of Bihar, which has been further divided into three sub-culture areas—Maithili, Magadhi and Bhojpuri. Each of these sub-culture-areas is distinguished by one particular regional dialect along with its distinct social traditions, historical settings and cultural characteristics, of course, in the broader framework of Bihar as a cultural region.

III. ARCHAEOLOGY

5. "Atlantis—The ancient home of the Dravidians".

J. T. CORNELIUS.

The origin of the Dravidians is a fundamental problem in the History of South Indians. The theory of indigenous origin of the Dravidians held by most South Indian, and some foreign scholars is shown to be untenable, and a theory of the Atlantean origin of the Dravidians from the so called 'lost continent of Plato's' is put forward in this paper.

The iron-swords in the Adichanallur in the Government Museum, Madras is identified with the Tang-Swords found in Greece and Egypt and dated to 1200 B.C. The 13th Century B.C. seems to have been the period of the great outward movement of these people from west, which brought them to the shores of southern India.

Section IX, Medical & Veterinary Sciences

1. Studies on outbreaks of Infections Bronchitis of Poultry in India.

P. G. PANDE and D. KRISHNA MURTY, Mathura.

Outbreaks of diseases resembling Coryza Infectiosa have been frequently reported from different parts of this country but no systematic studies seem to have been conducted to establish etiological agent associated with this disease. Detailed investigations were undertaken on four successive outbreaks of such a disease which occurred at one State poultry farm in Uttar Pradesh. The disease was very acute in the first year causing heavy mortality and involving almost all the young growing chicks available in the flock. In the subsequent years, the disease gradually became more chronic but affected the egg production of the recovered birds considerably. Detailed description of the characteristic respiratory symptoms observed in these birds have been recorded. During these studies it was observed that the disease was of viral origin and could be transmitted to healthy chicken. Recovered birds were immune to reinfection with the virus. Local strains of virus isolated from these outbreaks were successfully adapted to developing chick embryo where they usually produced dwarfing and curling of the embryo with an embryonal mortality of over 90% within five days after inoculation.

The local strains of the virus recovered from different outbreaks were found to be immunologically identical and by cross immunity tests, with Infectious Laryngo-tracheitis virus, they were found to be distinct from ILT virus. Cross immunity tests, virus neutralisation and serum neutralisation tests carried out with type strains of Infectious Bronchitis virus and specific immune sera obtained from United States, showed that the virus was immunologically identical with IB virus. Detailed studies were carried out to differentiate this disease from other poultry diseases.

During these studies, it was conclusively shown that these outbreaks were due to Infectious Bronchitis, a disease which was hitherto not reported in this country. Investigations carried out on a few outbreaks of this disease in other poultry farms in this State suggested that this disease is not so uncommon.

2. On the Validity of *Fasciola indica* Varma, 1953.

H. C. MALVIYA, Izatnagar.

The history of the common liverfluke (*Fasciola hepatica*) dates back to 1526 when Cosimus first observed an epizootic of distomatosis in sheep in Holland (Stiles, 1894). In 1758 Linnaeus proposed the name *Fasciola* for the genus represented by these worms with *Fasciola hepatica* as type species. Cobbold (1855) described another species of *Fasciola* from the liver of giraffe and named it *Fasciola gigantica*. Railliet (1895) described the form *P. hepatica* var. *angusta*, while Loos (1896) described another form *F. hepatica* var. *aegyptiaca*. Both these forms have been regarded as identical with *Fasciola gigantica* by Blanchard (1896). Leiper (1910) created another species *F. nyanzi* from hippopotamus, Jackson (1921) accepted *F. gigantica* and *F. nyanzi* as valid species. Sinitsin (1933) described two new species of liverfluke *F. californica* and *F. halli* from America. He differen-

tiated them from *F. hepatica* by the distribution and form of the cuticular scales in the adults and by certain additional features in their life histories. Varma (1953) described the common Indian liverfluke as *Fasciola indica*. Tandon (1956) regards the common Indian liverfluke as referable to *F. indica* without discussing the validity of the characters on the basis of which the new species was created. The present studies were undertaken to examine the validity of the species created by Varma (1953).

On the basis of these three characters (cuticular armature, gut branching and shape and size of the eggs) Varma created *F. indica*, n.sp., for the liverfluke commonly found in Indian ruminants. In order to study the validity of these characters a large number of specimens of *F. gigantica* and *F. hepatica* obtained from various hosts and localities in India were examined with particular reference to the constancy of the characters on which *F. indica* was based. A few specimens of *F. hepatica* were also obtained from the London School of Hygiene and Tropical Medicine. A single mounted specimen of *F. indica* was received through the courtesy of Dr. A. K. Varma. A clean lamb was experimentally infected with 25 metacercariae of *F. gigantica* and 8 adult flukes of the same age and maturity were obtained from the animal.

As a result of these studies all the three characters mentioned by Varma as distinctive of *F. indica* have been found to be extremely variable. They are not constant even in the specimen of liverfluke kindly supplied by Dr. Varma and labelled as *F. indica*.

It is therefore evident that none of the characters on the basis of which Varma (1953) created the new species can be used for the separation of *F. indica* and *F. gigantica*. Thus, *F. indica* falls into the synonymy with *F. gigantica*.

Incidentally, the morphology of *F. gigantica* has been studied in detail and certain features which have not been described before have been elucidated.

3. Control of the large intestinal roundworm of Poultry—*Ascaridia galli*.

H. D. SRIVASTAVA and H. C. MALVIYA, Izatnagar.

The success of poultry industry depends largely on keeping the birds free from worms. The most pathogenic helminth parasite particularly of young birds is the large intestinal roundworm, *Ascaridia galli*. A number of drugs have been used for its control, but none with entirely satisfactory results. Investigations were therefore undertaken to test the efficacy and the best mode of administration of piperazine citrate in controlling this widespread infection. A series of experiments were conducted to test the efficacy of the drug against both mature and immature worms. Young, clean birds were individually infected with known numbers of infective eggs of the parasite. After their droppings had become positive for the eggs of the parasite they were given in different experiments 0.5 gm. or 0.25 gm. of the drug individually, in drinking water and in mash. The droppings of the birds were examined for eggs both before and after the administration of the drug to determine the number of eggs per gram of faeces. The birds were autopsied at suitable times and their intestine examined for the presence of *A. galli*.

From the data obtained from the series of the experiments conducted it was seen that piperazine citrate at a dose rate of 0.5 gm. per bird was hundred per cent effective in eliminating the worms, irrespective of the mode of administration. At a dose of 0.25 gm. it was found to be hundred per cent effective when administered to the birds individually or in drinking water of a group of birds. However, in the case of one very heavily infected bird 0.25 gm. of piperazine citrate given orally expelled 96% of the worms. When given in mash 0.25 gm. of the drug was found to be 84.9% effective. Piperazine citrate was found to be ineffective against the caecal worm (*Heterakis gallinae*) and tapeworms.

Section X, Agricultural Sciences

1. Seasonal Variations of Chlorides and Soluble Salts in some Black Clayey Soils of Andhra Pradesh.

T. G. SASTRY and A. S. SASTRY, Rajahmundry.

The seasonal variations in the soil chlorine and total soluble salts were investigated on eight sites of black clayey soils. Two sites were selected in each of the following villages : Raghudevapuram, Muggulla, Kunavaram and Burugupudi. The sites from the first two villages were not saline while those from the last two were highly saline.

Soil samples were collected in two depths, i.e., 0"-9" and 9"-18" and analysed at 2-month intervals for soil chlorine and total soluble salts. It has been found that these constituents increased and attained a maximum with the onset of summer in the February-April period. The extent of variation in the saline sites is many times more than that in the nonsaline sites.

2. Presence of mycelium in different regions of sugarcane stem infected with *Ustilago scitamea* Syd.

S. K. SAXENA and ABRAR M. KHAN.

The presence of mycelium of *Ustilago scitamea* Syd. in different internodes of sugarcane has been doubted. The findings of the authors indicate that the mycelium is present in all the internodes of sugarcane plant.

The internodes of sugarcane plants, grown in autoclaved soil and inoculated with sugarcane smut were cut into pieces and were fixed in one part of acetic acid and three parts of absolute alcohol. Sections were made of different internodes by means of sliding wood-microtome and later stained. The mycelium of *Ustilago scitamea* was found to be present in the 1st internode as well as in basal internodes. It is not only confined to the parenchymatous but also present in the bundle sheath.

3. The nature of 'Dieback' Disease of Citrus in Bombay State and its control.

R. L. NAGPAL, Poona.

Citrus trees in Bombay State have been suffering from a number of disorders, which have commonly referred to as 'Dieback'. These diseases have led to a serious decline in acreage and the trees ordinarily becomes unproductive after only 10-15 years.

The studies carried over for the last few years have shown that improper selection of soil which may lead to waterlogging, foot rot etc. and the attack of various bark and stem eating insects may be the cause of decline, but in a vast majority of cases these factors are not the cause of disease. The analysis of leaf samples shows a deficiency of zinc, manganese and magnesium, and excessive concentration of iron, potash and phosphorus; but in most of the cases repeated attempts to cure the symptoms by accepted methods of soil application and sprays have either given negative results or have given only a temporary relief.

The studies show that in case of affected trees there is a pronounced necrosis of phloem at the bud union resulting in starvation of roots so that there is a progressive depletion of carbohydrates starting from the extremities of roots. The sour orange seedlings budded with infected budwood sprout as in normal cases but

the resulting budlings die within a year. The inoculation on acid lime seedlings results in the development of vein clearing of leaves and pitting of stem. The studies have shown the presence of tristeza, xyloporosis and psorosis virus diseases in almost all citrus plantations of Bombay State.

The use of nucellar seedlings as a scion for over a score of different rootstocks has shown that budlings with nucellar scion are 25-300% more vigorous than those with the present sources of budwood. It appears that the use of nucellar seedlings as scion and tolerant rootstocks is the most practical remedy against these virus diseases of citrus.

4. Detection of Organophosphorus insecticides in Food Stuff.

K. S. SRINIVASAN and S. K. MAJUMDER, Mysore.

A quick and simple method of detection of organophosphorus insecticides in foodstuffs has been standardised. Food material is extracted with petroleum ether and subjected to alkaline hydrolysis using potassium hydroxide. Development of golden yellow colour determines the presence of *p*-nitrophenol in the material. Organic phosphorus determination indicates the presence of organophosphorus compound in the petroleum ether extractive. Insecticides like diazinon, malathion do not give colour when hydrolysed with potassium hydroxide, while insecticides containing the *p*-nitrophenol moiety (parathion, paraoxon and methyl parathion) answer the test. Quantities even below 1 p.p.m. can be easily detected by this method.

Petroleum ether in the extraction of plant material was found to be superior to acetone, alcohol, benzene and chloroform with respect to the clarity and non-interference of pigment material in the colorimetric determinations. The intensity of colour developed in the case of parathion after alkaline hydrolysis using monoethanolamine, sodium hydroxide and potassium hydroxide indicates that potassium hydroxide is superior to the either alkalies tested and the sensitivity is more.

5. Relation between starvation and activities of first-instar hoppers of the desert Locust, *Schistocerca gregaria* Forsk.

S. A. AZIZ, Aligarh, U.P.

Humidity reactions of first-instar fed and conditioned hoppers of *Schistocerca gregaria* Forsk. have already been published (1957). Keeping in view the reaction of fed hoppers to the humidities, further studies on starved hoppers are done in the "alternative chamber" at 20°C and light intensity of 2.10 log foot lamberts. Newly hatched hoppers after feeding for two days were starved and preconditioned for 24-32 hours at 28°C and 77% R.H. Ten replicates, each of 30 minutes' duration and single hopper in each experiment, were done. Alternate relative humidity sets used were 65% and 70%, 50% and 60%, 60% and 70%, 70% and 80%, 80% and 90%, and, 90% and 100%. Time spent "active," time spent "inactive," number of hops, number of turnings, speed of walking, and time spent in each half of the chamber were recorded. It was found that starved hoppers are still able to discriminate between low and high humidities. They avoid low humidities below 70% R.H. and the high humidities above 70% R.H. The time spent by the starved hoppers in both halves is not well marked in relative humidities 50% and 60%, and, 60% and 70%. This is probably due to restless condition (more activeness) of the hoppers due to starvation. Starvation also effects gradual increase in levels of the activities (time spent "active", speed of walking, hopping and turning) up to 70% and 80% R.H. Adverse responses (decrease) in these levels of activities of the hoppers are recorded beyond 70% and 80% R.H. This is most marked in the moist air (i.e., 90% and 100% R.H.),

6. On some plant-parasitic nematodes occurring in South India, with the description of two new species of the Genus *Tylenchorhynchus* Cobb, 1913.

M. RAFIQ SIDDIQI and M. A. BASIR, Aligarh (U.P.).

Five species of the plant-parasitic nematodes including two new forms occurring in South India have been described. *Xiphinema insigne* Loos, 1949, *Rotylenchulus reniformis* Linford & Oliveira, 1940, and *Hemicycliophora longicaudata* Loos, 1948, have been reported for the first time from India and new hosts for them have been recorded namely coffee for the first two and sugarcane for the last one. Illustrated account has been given of *Tylenchorhynchus coffeae*, n. sp. and *T. mashhoodi*, n. sp. which have been collected from soil around roots of coffee plants growing in Coorg and Hasan districts, Mysore State and sugarcane in Coimbatore, Madras State respectively.

T. coffeae n. sp. is characterized by the coarse striations on the body cuticle, four incisures in lateral fields, four annules on lip region which is continuous with the body contour, buccal spear measuring $22\ \mu$ long and a cylindrical tail without striations around terminus. *T. coffeae* n. sp. is akin to *T. eremicola* Allen, 1955 and *T. nudus* Allen, 1955. It differs from the former in having a conoid lip region, rounded basal knobs of the spear and unstriated caudal terminus; and from the latter it is distinguished by the presence of four annules on the lip region as compared to only two in the case of *T. nudus*. *T. mashhoodi* n. sp. is distinctive because of coarse striae on cuticle, four incisures in lateral fields, continuous lip region with only three annules, $17-18\ \mu$ long buccal spear, presence of a spermatheca in each uterus, a conoid tail with only 13-15 annules and unstriated terminus and abundance of males. It is related to *T. clarus* Allen, 1955 but can at once be differentiated by the presence of only three annules on lip region.

7. Factors influencing the emergence of larvae of Root-Knot Nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

The influence of various physical factors on larval emergence in *Meloidogyne incognita* has been studied. Hatching tests were carried over wide range of Temperature, Hydrogen-ion Concentrations, Relative humidities and Illumination. Okra-root leachate and distilled water were employed as hatching media for making the tests. Larval emergence was observed at all temperatures between 0° and 50°C . in the leachate, and was greatly stimulated at 25°C . Hatching was poor in distilled water and showed poor response to temperature. Optimum hatching occurred at pH 7.0, and diminished gradually as the two media turned more acidic or alkaline. Larval emergency occurred at all the Relative Humidities tested, and optimum emergence took place at 81 per cent. Light had a profound influence, and an 18 hour day length proved to be the most favourable. It has been suggested that the remarkably enhanced leachate potency at 25°C might be due to some influence of temperature on the eelworm hatching factor, rather than directly on larval emergence.

8. Studies on Susceptibility of Common Woods to the Root-Knot Nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

The Host Range of the Root-Knot Nematode, *Meloidogyne incognita* on common weeds has been investigated by inoculating the plants with choppings

of infected okra roots. On examination of the root system, it has been found that out of the twenty-three wild species tested, sixteen were susceptible and the remaining seven were resistant. Plants of the family Euphorbiaceae were found to be highly resistant. Weeds of other taxonomic groups differed in their degrees of susceptibility. The identification of the nematode was confirmed by a study of the Perineal Patterns of the females and by the Host Reaction tests introduced by Sasser.

9. Physico-chemical changes in valencia orange concentrate during commercial scale vacuum concentration.

J. S. PRUTHI, Mysore.

Changes in refractometric solids ($^{\circ}$ Brix), viscosity, spectral reflectance (colour), pH, acidity, $^{\circ}$ Brix/acid ratio, colour true ascorbic acid and carotene during commercial scale vacuum concentration of valencia orange juice in a forced circulation, single-pass, Falling-Film Evaporator have been reported.. With the advancing concentration, there was a gradual increase in $^{\circ}$ Brix, acidity, viscosity, colour, ascorbic acid and carotene, no change in $^{\circ}$ Brix/acid ratio but a slight fall in pH. Upto 4-fold concentration of the juice, the increase in viscosity was comparatively slight, but after 5-fold concentration, there was a steep rise in viscosity. There was negligible loss in carotene while the losses in true ascorbic acid were well within 5% during concentration upto 63 $^{\circ}$ Brix.

Use of mid-season, healthy ripe oranges for juice extraction and concentration of the flash-heated juice (195 $^{\circ}$ -200 $^{\circ}$ F for 10-12 seconds) upto 5-fold level are suggested.

10. Studies on Passion Fruit juice concentrate and powder.

J. S. PRUTHI and GIRDHARI LAL, Mysore.

In recent years, fruit juice concentrates have attained an increasingly important position in the food industry. This rapid development has to a large extent, been attributed to the fact, that they reduce packaging, shipping and storage costs and also increase their convenience in homes, institutions and remanufacturing trade. Considerable amount of experimental evidence is now available in literature on the concentration and dehydration of a number of fresh juices, but information pertaining to the concentration of passion fruit juice is rather scanty and incomplete. The present report deals with the changes in the physico-chemical composition of the juice during vacuum concentration and dehydration.

The ascorbic acid and carotene losses during vacuum concentration of the juice ranged from 6.0 to 10.1% and 3.2 to 6.9% respectively, the ascorbic acid content of the final concentrate (72 $^{\circ}$ Brix) being 120.1 to 228.2 mg/100g. (Av. 160 mg 100g.) and carotene 1.85 to 3.92 mg/100g., depending upon the initial ascorbic acid and carotene content of the juice.

The losses in ascorbic acid and carotene during vacuum drying ranged from 5.1 to 10% and 2.5 to 4.7% respectively, the overall losses during vacuum concentration and dehydration for the two vitamins being of the order 10-20% and 5-9% respectively.

11. Optimal harvest time for Valencia Oranges for orange concentrate manufacture

J. S. PRUTHI, Mysore.

For the manufacture of good quality orange concentrate, oranges of suitable variety picked at optimum maturity are needed throughout the season. The con-

concentrate Industry being still in its infancy in this country, as yet no precise Quality Standards are available for orange juice to be used for the manufacture of orange concentrate. Besides, little published information is available on the seasonal variation in the chemical composition of oranges and on the optimal harvest time for oranges for orange concentrate manufacture. This paper covers all these aspects of Valencia Oranges. The work was carried out in Australia.

Based on the detailed study of physico-chemical characteristics of valencia oranges during the season 1956-57, the following conclusions have been drawn :

1. The optimal harvest time for valencia oranges required for juice and concentrate manufacture would commence a little after the middle of November. Previous to this, the juice is too acidic (acidity 1.23 to 1.96) and has low Brix/acid ratio (6.25 to 10.06), although it was quite normal for pulp and oil content.
2. For frozen orange concentrate, it would be advisable to commence concentrate manufacture still a little later viz. about the end of November, when the Brix/acid ratio reaches just the bare minimum (12.0).
3. Similar detailed work would be necessary to determine the optimal harvest time for Indian Mandarine (Nagpur, Coorg and Assam loose-skinned oranges) required for the manufacture of good quality concentrate, rich in flavour, free from bitterness, normal with respect to pulp and oil content, Brix/acid ratio and vitamin C.

12. Studies on Equilibrium Relative Humidity (E. R. H.) of garlic powder.

J. S. PRUTHI, L. J. SINGH and GIRDHARI LAL, Mysore.

For systematic studies on packaging requirements and storage characteristics of foods in general and dehydrated foods in particular, the measurement of Equilibrium Relative Humidity (E. R. H.) is of considerable importance. Little published information is available on E. R. H. of garlic powder which appears to be a very highly hygroscopic product. This paper covers this important aspect of garlic powder.

Based on sorption isotherm or E.R.H. curve, the following conclusions have been drawn :

1. Garlic powder is a highly hygroscopic product, picking up moisture even at 20% R.H.
2. For a typical garlic powder (moisture 6%), the equilibrium relative humidity at 25°C is about 13%.
3. The critical point for garlic powder was found to be at 10.6% moisture level, danger point at 9.5% and safety range between 9.5 and 10.6% moisture level.

13. Proteins fractions of (1) the self humified weed zhoonjru (*melilotus indica*), (2) Agra soil treated with zhoonjru for 4 months and (3) untreated Agra soil.

NEWTON RAM, Agra.

The experience of the previous workers Archard, Vanquelin De Saussure, Sprengel, Berzelius, Boullay, Mulder-Herrmann, Detmar and Hoppe-Seyler, Deherain and others clearly point to the fact that humus was not a chemically pure substance and hence it was well nigh impossible to derive any chemical formulae by analytical methods for this unusual type of a complex substance. According to Waksman

humus is a lignin-protein complex formed by the microbial synthesis of nitrogenous substance in the plant residues.

In view of the embarrassing complexities of the humus and humic fractions I have attempted to throw some light on them by studying the hydrolysis of these fractions in 6 N.HCl. The humic fractions of the untreated soil and of the soil treated with plant material under humification for four months were refluxed with 6 N.HCl. These fractions were obtained by two methods, viz. (1) by ammonia method (Hilgard and Jaffa) and (2) by alkali treatment (Schreiner and Shorey) and their percentage hydrolysis in 6 N.HCl was quantitatively studied. The protein fractions were isolated by different solvents from the untreated and treated soil and their hydrolysis in 6 N.HCl was also studied. Quantitative isolation of Protein of the self humified weed *Zhoonjru* (*Melilotus Indica*) and the degree of their hydrolysis have been further studied. From such observations I have attempted to make a comparative study of the nature of proteins obtained from (1) the untreated soil, (2) Soil treated with *Zhoonjru* (*Melilotus Indica*) and (3) the self humified weed *Zhoonjru* which was left to humify for four months. The interesting results throwing some light on the similarities and dissimilarities of the proteins isolated from the humified weed (*Zhoonjru*) and the treated and untreated soils have been critically examined and discussed in this paper.

Section XI, Physiology

1. Modifications of Bioelectric Potentials of Brain, Heart and Muscles in the Practice of "Yoga" (specially in Asana and Pranayama).

N. N. DAS, Calcutta.

Yoga is a technique by means of which one can make a harmonious development of body & mind. Thirty subjects were selected from amongst the persons who regularly practice yoga (including some Yogis) and thirty controls who do not practice yoga. For each individual case the experiments were repeated at least five to 10 times in the same environment and conditions.

The subjects were taken to air conditioned room, with complete sheilding and sound proofing. Before records are taken temperature and humidity are controlled. Records are taken with Gras EEG machine, model III console. First a few yogasans were taken, and the records of EEG, EKG, and EMG were taken of Practitioners and Novices. Then the records of Pranayama; were taken. The special Type of Pranayama Vastrika, Bramari is taken into consideration.

Conclusion

In different asanas the record shows slight modifcans in the pattern of records, of Bioelectric potentials in heart and respirations. In pranayama there is some EEG changes which is demonstrated in the diagrams and records.

- (1) Conception of yoga (8 limbs) ancient culture.
- (2) Utility in daily life (balanced human mind).
- (3) Experimental Study (pictures).
- (4) Findings.
- (5) Conclusions.

2. Some Observations on Panting.

M. S. CHAUDHURY, Calcutta.

The author had read a paper at the Calcutta Session of Science Congress in which he had discussed the effect of anaesthesia on a special respiratory reflex in heat regulating mechanism of dogs. ...

Further work has been done on unanaesthetized dogs. The dogs were heated either in a special chamber provided with heating arrangements or they were tied in the sun and suns rays heated them.

It has been observed (1) that panting does not start before the rectal temperature goes up by $.2$ to $.3^{\circ}\text{C}$, (2) that the external temperature has no effect on panting in dogs, (3) that if the mouth of the dogs is tied with a rope tightly so that they can not open it they can not pant.

The findings of Richet (1898) as quoted by Anrep in 1933 are contradicted.

3. Observations on the Electro-Physiology of the avian central auditory pathway.

M. P. SINHA, Patna.

A systematic study has been made to observe the transformation of the auditory message as it is transmitted through this central pathway in young and adult pigeones.

1. Click response has been recorded from the primary auditory nuclei of the medulla and the midbrain and shiatal complex.

2. (a) The latent period of response = 1.5 to 1.2 milli sec. for the primary and 12 to 15 m./sec.

(b) Fneg. range 100 to $10,000$ /sec.

(c) Synchronisation and phase relationship between the stimulus and the response breakdown at higher frequencies.

3. There appears to be no significant change indicating fatigue on prolonged estimation.

4. The area giving response was localized.

5. Apparent inhibition of response was indicated and its possibilities discussed.

4. Observation on the Electro-Physiology of the Avian Central Auditory Pathway.

M. P. SINHA, Patna.

The way the sound stimulus is registered by the Phono-receptors of the ear and its transformation by the central auditory system, is still relatively little understood. The various theories of hearing either take into account a preliminary peripheral analysis of sound by the basilar membrane, or, the analysis of pitch discrimination by the cortical neurones. However, fishes have no basilar membrane and removal of the cortical neurons in mammals (cats and dogs) do not affect sound registration and pitch discrimination (8). Therefore what transformation take place in the intervening pathways must be important from this stand point, and whatever that has come to light, has been obly recently through the methods of Electro-Physiological studies. In this, there is an obvious complication. The nature has produced many patterns of auditory systems in its wide laboratory of evolution. The avian system has apparent simplicity of structure, a straight uncoiled Cohlea, and relatively simple central pathway. A systematic study has been therefore made to observe the transformation of the auditory message as it is transmitted through this central pathway. The preliminary observations as seen in young and adult pigeons, are being presented as follows :—

1. Click response has been recorded from the primary medullary cochlear nuclei, nucleus magnocellularis, nucleus angularis and nucleus laminaris and also from the midbrain nuclei and striatal complex.

2. The latent period of response appear very nearly the same i.e. 1.5 and 1.2 milli second for the primary and 12 to 15 m. sec. for the midbrain and striatal complex and cover a frequency range from 100 cycles second to $10,1000$ cycles per sec.

and the synchronisation and phase relationship between the stimulus and the response, breakdown at higher frequencies.

3. Even on prolonged stimulation, there does not appear to be any significant increase in latency of response to denote fatigue.

4. The extent of response is stretching more transversely from about one mm. and a half from the mid line to almost 4.5 mm. laterally and antero-posteriorly one folium of the cerebellum so far appears to be the maximum limit. The response is obtained both from the ipsi-lateral and contra-lateral ears, though that from the same side is better than from the other.

5. Apparent masking and inhibition of the response has been indicated.

(a) On sounding a note the spontaneous discharge is diminished.

(b) Simultaneous sounding of two notes which are individually equi-potent to give a response, if sounded together give inhibition in the response or completely block it.

(c) Stimulation of a limited area from the floor of fourth ventricle, suppresses the tonal response.

(d) Any painful stimulation suppresses the tonal response.

Response has also been reported from a small region of the neostriatum caudale (latency 13 milli second) (4).

Potentials observed at the startial area has a longer latency and there was some functional overlap of the area giving responses to tactile stimuli, and that which yielded acoustic responses, when the electrode was closed to the boundary between the two regions responses to both tactile and auditory stimuli were frequently recorded from the same electrode position (4).

From the above, it may be noted that there are modifications in the message as transmitted even in as simple an auditory system as that of the bird. Furthermore, there are spots from which auditory and tactile responses can be obtained and this might explain how birds without internal ear could listen through their skin. The responses need be investigated with more refined technique when it is expected that a point to point projection of the cochlea is likely to be noted from the cochlear nuclei, other observations need be investigated more completely.

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5. An Observation with Chloralose Anaesthesia in Dogs.

SURENDRA KUMAR and A. S. SINHA, Patna.

During the course of experiments designed to study the mechanism of temperature regulation in dogs, it was observed that chloralose is the anaesthetic of choice for experiments on autonomic nervous system and organs under its control. The anaesthesia at their normal body temperature lasted for six to eight hours when chloralose was given at the rate of 75-80 mg. Kg body weight. At raised body temperatures the effect of anaesthesia markedly faded within four hours.

Since urine output decreases at high body temperatures and chloralose is a non-volatile anaesthetic, it is suggested that it is more quickly destroyed in the body at higher temperatures.

6. An Observation with Chloralose Anaesthesia in dogs.

SURENDRA KUMAR and A. S. SINHA, Patna.

In experiments that are designed for determining the physiology of the nervous system specially that of the autonomic nervous system and of the organs innervated by it, chloralose is the anaesthetic of choice. During the course of experiments designed to study the mechanism of temperature regulation in dogs it was observed that though chloralose is the anaesthetic of choice for experiments on autonomic nervous system and the organs under its control, yet under certain circumstances it is not a perfectly carefree anaesthetic.

The amount of initial chloralose that was given after a preliminary ether anaesthesia in these dogs varied between 75—80 mg. per kilogram of dogs weight, and the experiments lasted for a variable period up to eight hours.

During the course of these experiments animals had to be heated up or cooled down. It was observed that the initial chloralose anaesthesia was carefree when doing cooling experiments, or experiments at their normal body temperatures. The anaesthesia lasted for six to eight hours after the initial dose. But, if the dogs were heated up and their body temperatures raised the anaesthesia became light in less than four hours and an extra dose of chloralose had to be given to keep them under.

Chloralose being a non-volatile anaesthetic, it is not expected that it will pass out easily through breath. Further it has been observed that the excretion of urine also gets less during such experiments. It is not likely therefore, that chloralose can be excreted in larger amounts at high body temperatures. It is therefore, suggested that chloralose is more quickly destroyed in the body at higher temperatures.

7. Effect of Gonadectomy on Experimental Peptic ulceration.

S. B. SINGH and R. C. SHUKLA, Lucknow.

Experimental studies on the effects of gonadectomy on gastric mucosa and the gastric secretion of normal and ulcerated rats were done. Ovariectomised rats showed increased degree of gastric ulceration and significantly higher values of peptic activity than non-ovariectomized rats. The possible mechanism of increased degree of ulceration has been discussed. Orchidectomy did not influence either the gastric secretion or the degree of ulceration. Gonadectomy alone, without pyloric ligation, had no ulcerogenic effect on the gastric mucosa.

Section XII, Psychology & Educational Sciences

1. A case study of Multiple Personality.

V. K. ALEXANDER, Alwaye.

Soosan, a young village girl, aged 15 was brought to the writer by her father in May 1952, with the complaint that she was possessed by *two* evil spirits. One of the evil spirits was that of a young man who committed suicide when the girl was 3 years old, and the other was that of a grand-aunt of hers who died years back even before the birth of the girl,

This case was undertaken by the author for treatment and careful study. Analysis showed that the evil spirits were nothing but her own repressed oedipus feelings. When the analysis was over and the girl had a real insight into her own problems, she was relieved of her symptoms. It is now six years since the therapy was terminated; she is free from those attacks and has had no relapse ever since.

It is the *hypothesis* of the author, that such cases of multiple personality are not cases of dissociation as a number of psychologists consider them to be, but only a case of repression and identification with the repressed experience. Here in this case, the girl had repressed her oedipus feelings and that created tremendous tension in her mind. Since the repression was only partially effective, her ego was forced to use another mechanism of defense; in this case identification with the repressed experience to relieve the inner tension. Identification with the repressed experience assumed the role of evil spirits, because of cultural background and also the help that it gave for the expression of her repressed experience. This saved her from the blame of society as well as from that of her super-ego. That is why such cases of multiple personalities appear only in cultures where people believe in evil spirits.

2. A study of the causes of Social Acceptance and Rejection among Adolescent School Students.

ADARSH KHANNA, Delhi.

The *aim* of the investigation was to discover the causes of social acceptance and social rejection among adolescent girls and boys and to clarify some of the factors which make for such acceptance and rejection. The *subjects* were 300 VIII and IV class girls and boys, aged between 11 and 18 years, studying in different city schools of Jullundur. The Normative survey method was followed. An extensive questionnaire was prepared and administered. Psychometric techniques were employed where necessary in tabulating and classifying the data.

Results :

1. The adolescent boys and girls have a natural craving for friends. 80% of the adolescents under study have more than three friends.
2. As the adolescents grow in age, there is a *tendency towards narrowing down the circle of friends* and confining their friendships to a few friends whom they consider desirable.
3. The boys and girls in the period of *early adolescence* confine their friendships to the members of their own sex.
4. The *intimate friends* are most liked for talking together, for inviting to birth-day parties and for studying together.
5. Similarity of interests is an important factor in the determination of friendships.
6. Important traits of the accepted students emphasized by the boys as well as girls are : 'clever in studies, good nature, honest, kind, helping nature, same age, social nature, good habits, cheerful nature, sympathetic, beautiful', etc.
7. The *rejectees* are not disliked as companions for talking together, sitting together and studying together.
8. The *disliked traits* of the rejectees emphasized by the girls as well as boys are : habit of stealing, ill-tempered, weak in studies, vanity, habit of telling lies, quarrelsome, dishonesty, dirty dress, selfishness, cunningness and unkindness.
9. Interference by the parents, teachers, brothers, sisters and fellow-friends is one of the factors affecting the *choice and rejection of friends*.

3. An Attempt to Standardise Mac Quarrie Mechanical Ability Test.

S. N. ROY, D. BANERJEE, S. DEB, R. KUNDU and B. GANGULY, Calcutta.

The Mac Quarrie Mechanical Ability Test, a test of paper and pencil type, was administered, under the auspices of the Applied Psychology Section, Calcutta Uni-

versity, over 430 candidates of whom 168 completed trade apprenticeship training ranging between $2\frac{1}{2}$ to 3 years and the remaining 262 being applicants for apprenticeship training at Chittaranjan Locomotive Works, Chittaranjan. Criteria like Stenquist Mechanical Assembly Test, Trade Achievement Tests, Technical School Annual Examination results (for 168 candidates only) have been used for purposes of validation of Mac Quarrie Mechanical Ability Test. On the basis of these findings suggestions for certain modifications have been made so that Mac Quarrie Test may be used as a dependable test of mechanical ability for guidance and selection works.

Section XIII, Engineering and Metallurgy

1. Some physico-chemical and mineralogical characteristics of marine clays from Bombay and Cochin harbours.

B. C. DEB, Poona.

A detailed physico-chemical and mineralogical study of the marine clays of Bombay and Cochin and Black Cotton Soil from Poona shows that :

- (i) They are highly colloidal, contains about 70-80 p.c. clay.
- (ii) Both the marine clays have high liquid limit and plasticity index under wet condition and also retain a high amount of water on settlement. These are reduced considerably on drying and become of the same order as that of black cotton soil.
- (iii) That chemical composition of all the clays shows that $\text{SiO}_2/\text{R}_2\text{O}_3$ ratios are fairly high and all the clays contain appreciable amount of non-exchangeable magnesium, indicating the presence of montmorillonite.
- (iv) Electrometric Titration, Viscosity and thermal analysis curves for marine clays as well as black cotton soil are all similar to montmorillonitic clays.
- (v) The base exchange capacity of the marine clays especially Cochin clay is some what lower than montmorillonitic clays.

It has been concluded that the marine clays are mainly montmorillonitic but slightly modified by marine diagenesis.

2. Possibility of nickel manufacture in India.

V. A. ALTEKAR, Bombay.

Importance of nickel as an essential metal to the industrial India has been outlined, and the economic position of this metal brought out. A survey has been made of the reported nickel finds in India with particular reference to the occurrence of nickelliferous minerals in the copper belt of Singhbhum, Bihar. The importance of this occurrence as an economic source of nickel has been brought out. It is observed that at the present annual rate of copper ore production recovery of the 60,000 lbs. of nickel contained therein deserves attention on grounds of high intrinsic value, strategic nature, and current import difficulties.

The practicability of the nickel recovery programme is justified on the grounds that it would be a bye-product recovery with a major expense item of grinding already incurred for copper. Current trends in Western mills for trace-element recoveries are cited.

It has been observed that the ideal way for recovery of nickel would one which would least interfere with the current established procedure for milling and smelting for copper. It has been suggested that treatment of mill tailings and dump slags would be only two steady sources for nickel recovery programme.

The nickel balance of the present milling and smelting operations has been worked out. It is observed that about 75% of the nickel in the ore is to be found in the tailings; another 15% is to be found in the dump slags and about 10% of the original nickel is being obtained in the refined copper. It is thus seen that a bulk of nickel could be obtainable in the final waste products of the present operations.

Experimental work done by Chatterji et al, Altekar and Sandhir, Altekar and Midha on mineralogical and electrographical studies; by Altekar on nickel distribution in, and sink and float studies of the I.C.C. tailings; by Altekar and Midha on gravity and flotation treatment of tailings; by Khare on nickel recovery from nickel-rich circulating slags of the smelter and by Altekar, Sharma and Dixit on treatment of dump slags of the smelter has been surveyed. It has been pointed out that the results obtained so far not conclusive and that sustained efforts should be continued in this direction. Interest and co-operation of the Indian Copper Corporation is acknowledged.

3. Considerations in the design of textile air-conditioning equipment.

P. C. GUPTA, Delhi.

Stress has been laid on the desirability to fix design standards for air-conditioning industry for the benefit of the designer as well as the customer. Heat load has been discussed in detail along with the factors that go to make it up. The various components of the heat load are given percentage-wise and suggestions are given to reduce their values and thus make a more economical equipment possible. It has also been shown that a refrigerative type plant is more suitable and is bound to prove economical in the long run.

4. Choice of optimum controller setting under alternating load of controlled process and correction of setting during operational maintenance of controlled systems.

I. V. ANISIMOV, UNESCO Expert.

The methods of calculating the optimum controller setting known in literatures and industry have been worked out for certain constant operational conditions of a controlled system.

In industry, however, a process load as well as a number of parameters of a control system may alter substantially which causes the necessity of changing the controllers setting.

The author worked out the methods for choosing the optimum controllers setting under an alternating process load and for correcting the setting under the change of calculation parameters of a control system. Optimum setting of a controller under an alternating process load is chosen in the way to provide for the desired average damping degree under a normal load and for the minimum admissible damping degree under the most difficult operational conditions, that take place usually under the minimum load. The formulae are derived for calculating the correction coefficients that take into account the following factors: change of the limits of the scale of a controller after the replacement of the latter, actual value of operational band of the flow characteristic of the controlling valve and the stiffness of its spring, change in the maximum carrying capacity of the controlling valve, alteration of the variables of the controlling medium, alteration of the average value of a process load.

The total correction coefficient to set the proportional bands value is equal to the product of partial correction coefficients. The effect of the changes of the above variables on the value of integral action time is usually relatively small and is often neglected.

DISCUSSION

I. ABSOLUTE SUMMABILITY OF SERIES INTEGRALS

Section of Mathematics

Chairman :—PROF. M. RAY, Agra.

1. S. R. SINHA (Allahabad) : *Absolute Summability Factors.*

Given a sequence $\{\lambda_n\}$, if a series of $\Sigma \lambda_n a_n$ is absolutely summable in some sense, while, in general, Σa_n is itself not so summable, then $\{\lambda_n\}$ is said to be an absolute summability factor of the series Σa_n .

In 1925 Kogbetliantz [Bull. des Sc. Math. (2), 49, 1925] proved that if Σa_n is summable $|C, \sigma|$, $\delta > 0$, then the series $\Sigma a_n n^{-\gamma}$, $0 \leq \gamma \leq \delta$, is summable $|C, \delta - \gamma|$. The restriction $\gamma \leq \delta$ was relaxed by Sunouchi [Jour. Math. Soc., Japan, 1, 1949].

The first application of the absolute summability factors to special infinite series is due to Prasad [Proc. Lond. Math. Soc. (2), 35, 1933] who established that for a Fourier series

(I) $(1/2) a_0 + \sum_{n=1}^{\infty} (a_n \cos nt + b_n \sin nt) = C_0 + \sum_{n=1}^{\infty} C_n(t)$ if $\{\gamma_n\}$ be any one of the sequences

$$(II) \left[\begin{array}{c} (\log n)^{-1-\varepsilon}, \{ (\log n)^{-1} \log \log n \}^{-1-\varepsilon}, \\ \dots \dots \{ (\log n)^{-1} \dots \dots (\log \log \dots \log_p n) \}^{-1-\varepsilon} \end{array} \right], \varepsilon > 0,$$

then the series $\Sigma \lambda_n c_n(t)$ is summable $|A|$ for almost all values of t . Prasad also proved a parallel theorem for conjugate series. Izumi and Kawata proved [Proc. Imp. Acad., Tokyo, 40, 1938] that Prasad's result holds even when we replace the sequence of summability factors by the more general sequence $\{\lambda_n\}$, where $\{\lambda_n\}$ is convex and such that $\Sigma n^{-1} \lambda_n$ is convergent. Chow established (J.L.M.S. 16, 1941) that for such a sequence $\{\lambda_n\}$ the series $\Sigma \lambda_n c_n(t)$ is summable $|C, 1|$ for almost all values at t . He based the proof of his theorem on a result of Marcinkiewicz (J.L.M.S., 40, 1939) concerning the strong summability of Fourier series. The set of points at which his result holds, is, therefore, not necessarily the Lebesgue set in which Prasad's result holds. Later Cheng proved (Duke Math. J., 15, 1948) that if $\{\lambda_n\}$ be any one of the sequences (II) the series $\Sigma \lambda_n c_n(t)$ is summable $|C, \alpha|$, $\alpha \geq 1$, in the Lebesgue set. Pati generalised (Duke Math. J., 21, 1954) all these previous results by replacing the sequences (II) in Cheng's theorem by the more general class of summability factors $\{\lambda_n\}$, where $\{\lambda_n\}$ is a convex sequence such that $\Sigma n^{-1} \lambda_n < \infty$. He has also obtained the result that if an infinite series Σa_n is strongly summable $[C, 1]$ and $\{\lambda_n\}$ is a convex sequence such that $\Sigma n^{-1} \lambda_n < \infty$, then $\Sigma \lambda_n a_n$ is summable $|C, 1|$. Prasad and Bhatt have carried this line of investigation still further and have also deduced [Duke Math. J., 24 (1957)] Cheng's theorem on the absolute summability of $\Sigma c_n(t) / (\log n)^{1+\varepsilon}$

[Duke Math. J., 15, 1948] by an application of a theorem of Pati (loc. cit.). Recently Chow [J.L.M.S., 29 (1954), 469-476] and Bosanquet and Chow [J.L.M.S., 32, (1957), 73-82] have established certain results concerning the absolute summability factors of general infinite series. Pati and Sinha [Volume of Abstracts, Current session of the Indian Science Congress] have extended, in a certain sense, these results for a Fourier series, by introducing the notion of hyper-convexity.

Bosanquet has given a class of theorems (J.L.M.S., 20, 1945) while determining the necessary and sufficient conditions required to be satisfied by a sequence $\{\lambda_n\}$ in order that the series $\sum \lambda_n a_n$ may be absolutely summable in the Cesàro sense of a given order whenever $\sum a_n$ is absolutely summable in the Cesàro sense of a certain order. Tatchell (J.L.M.S., 29, 1954) has obtained the analogue for absolute summability of a well-known theorem of Hardy and Riesz, which includes as a particular case a previous result of Mohanty (J.L.M.S., 25, 1950).

2. T. PATI (Allahabad) : *Regularity and Inclusion Theorems.*

In the theory of summability one of the most important problems is to determine necessary and sufficient conditions for the regularity, or, more generally, the conservativeness, of the transformation T defining the process. This problem has been completely solved by Toeplitz-Steinhaus and Kojima-Schur respectively. Solutions of analogous questions for absolute summability process have been given by Mears, Sunouchi and Knopp-Lorentz for matrix transformations, and by Knopp-Lorentz, Sunouchi-Tsuchikura and Tatchell for integral transformations. The results of Sunouchi and Knopp-Lorentz are of the same order of generality as the theorem of Mears concerning matrix transformations. Where they differ is in the technique of proof, which is based upon functional analysis. Even between the techniques followed by Sunouchi and Knopp-Lorentz there is difference. While the former employs a method developed by Bosanquet-Kestelman, the latter authors adopt a method similar to one adopted by Hahn to simplify the proof of the familiar Toeplitz-Steinhaus theorem. With regard to integral transformations, the conditions which had been shown by Knopp-Lorentz to be sufficient for absolute regularity there have been shown by Tatchell and Sunouchi-Tsuchikura to be both necessary and sufficient. Although the assumptions of Sunouchi-Tsuchikura regarding the kernel of the transformation are more restrictive than those of Tatchell, their result is more satisfactory in a certain sense.

The most familiar inclusion relations are $|C| \subset |A|$ and $|C, \alpha| \subset |C, \beta|$ for every $\beta > \alpha > -1$, due respectively to Fekete and Kogbetliantz. A very short proof of the last relation is due to Hilda Morley. A number of inclusions relations between absolute Nörlund, Cesàro and Abel methods have been observed by Mc Fadden. The inclusion-chain : $|L| \subset |A| \subset (L) \subset (A)$ is due to Winter and Hardy-Littlewood. The most interesting inclusion theorems seem to be those concerning the relative effectiveness of any two Riesz method of absolute summability. In this line, the so-called "first theorem of consistency", due to Obrechhoff, states that $|R, \lambda_n, k| \subset |R, \lambda_n, k'|$ for every $k' > k \geq 0$, while the so-called "second theorem of consistency" states that $|R, \lambda_n, k| \subset |R, \varphi(\lambda_n), k|$, $k > 0$, provided $\varphi(t)$, assumed to be monotonic increasing for $t > 0$, behaves in a sufficiently regular manner for large t . The most satisfactory theorems in this direction are due to Guha and Prasad and Pati for the cases of positive integral and non-integral order of summability, respectively. The present speaker is engaged in researches with a view to proving the "unified theorem of consistency", envisaged by Prasad in his talk at the International Congress of Mathematicians in Amsterdam (1954).

3. (KUMARI) PRAMILA SRIVASTAVA (Allahabad) : *The Absolute Summability of Dirichlet Series and Laplace Integral.*

The series

$$(1) \sum a_n e^{-\lambda_n s},$$

where $\{\lambda_n\}$ is a sequence of real increasing numbers whose limit is infinity, $s = \sigma + it$ is a complex variable whose real and imaginary parts are σ and t , is called a Dirichlet series of type λ_n . When $\lambda_n = \log n$, the series (1) is called an ordinary Dirichlet series. The series (1) is also written as

$$(2) \sum a_n l_n^{-s},$$

where $l_n = e^{\lambda_n}$.

The Laplace integral

$$(3) \int_0^{\infty} e^{-su} a(u) du$$

is the continuous analogue of the Dirichlet series (1). We may consider instead the more general Laplace Stieltjes integral

$$(4) \int_0^{\infty} e^{-su} dA(u),$$

which reduces to the Laplace integral (3) if

$$A(x) = \int_0^x a(u) du$$

And for the particular case when $A(u)$ is a step function defined as follows

$$\begin{aligned} A(x) &= 0, \text{ for } 0 \leq x < \lambda_0 \\ &= a_0 + a_1 + \dots + a_n, \text{ for } \lambda_n \leq x < \lambda_{n+1}, \end{aligned}$$

the integral (4) reduces to the Dirichlet series (1). Also absolute summability (R, λ, k) , or summability $|R, \lambda, k|$ of the Dirichlet series (1) reduces to summability $|C, k|$ of the Laplace Stieltjes integral (4). Consequently whenever the results for the Dirichlet series have their analogues for the Laplace Stieltjes integral these results in the latter form are more general.

It has been proved that there exists an abscissa $||\bar{V}_k||$ of summability $|C, k|$ for the integral (4) such that (4) is summable $|C, k|$ for all s to the right of the line $\sigma = \bar{V}_k$ and is not summable to the left of this line (see Bosanquet, Proc. Lond. Math. Soc., 1953; for the Dirichlet series this was proved by Obreschkoff, Math. Zeitschrift, 1929). In fact the integral is not even summable $[C, k]$ to the left of the line $\sigma = ||\bar{V}_k||$ the abscissa of strong and absolute summabilities being the same (Srivastava, Proc. I. S. C. A., 1956). If the integral (4) is summable $|C, k|$ for $s = s_0$ and it represents the function $f(s)$, then for $R(s) \geq \sigma_0 + t > \sigma_0$ we have $f(s) = O(t^k)$ (see Obreschkoff, loc. cit.).

The relationship between the abscissa of summability $|C, k|$ of the integral (4) and the abscissa of summability $|C, k-1|$ of the integral

$$\int_0^{\infty} e^{-su} A(u) du$$

has been discussed in detail by Bosanquet (loc. cit.). Concerning the behaviour of the (C, k) mean of $\int dA(u)$ with regard to the summability $|C, k|$ of its Laplace

transform, i.e. the integral (4), it has been proved that if the integral (4) is summable $|C, k|$ for $s=s_0$, then

$$e^{-sx}x^{-k}$$

for all s on the line $\sigma=\sigma_0$ (Issacs, Jour. Lond. Math. Soc., 1953; see also Bosanquet, loc. cit.).

As in case of the abscissa V_k of ordinary summability, $\bar{V}_k$ is a decreasing function of k . Also

$$\bar{V}_{k+1} \leq V_k$$

For the Dirichlet series (1) the abscissa summability $|R, l, k|$ has also been shown to exist. As in the case of ordinary summability, this abscissa is the same as the abscissa of summability $|R, \lambda, k|$ (Tatchell, Jour. Lond. Math. Soc., 1954). Further if σ_k and $\bar{\sigma}_k$ denote the abscissae of summabilities (R, l, k) and $|R, l, k|$ of the series (2), then

$$\sigma_{k+x} \leq \sigma_k + (1-x) D, \quad k \geq 0, \quad 0 \leq x \leq 1,$$

where

$$D = \lim_{n \rightarrow \infty} \frac{\log n}{\log l_n}$$

(Bosanquet, Jour. Lond. Math. Soc., 1947; Austin, Jour. Lond. Math. Soc., 1952; Borwein, Jour. Lond. Math. Soc. 1955). Bosanquet (1947) has also pointed out the failure of this property for integrals. For the ordinary Dirichlet series a number of relations between the abscissae of ordinary, strong and absolute summabilities have been given by Richert (Gött. Nach., 1956).

In case of ordinary summability various other problems such as converse theorems on the abscissa of summability and Tauberian theorems have been discussed by a number of authors (see Chandrasekharan and Minakshisundaram, 'Typical Means', (1952). Analogous problems in case of absolute summability may offer a fruitful line of investigation.

Another interesting problem is to investigate the abscissa of absolute summability of the Dirichlet product $\sum c_n e^{-n^s}$ of two Dirichlet series $\sum a_n e^{-\lambda_n s}$ and $\sum b_n e^{-\mu_n s}$. For ordinary Dirichlet series this has been investigated by Bohr (Math. Zeit., 1950 and Mat. Tidskr. B, 1950). The corresponding results for the absolute summability has been given by the present authoress (in an unpublished paper).

Regarding the behaviour of $(R, \nu, k+k')$ mean of the series $\sum c_n$, it follows from a result of Issacs (loc. cit.) and Theorem 3. 92 of 'Typical Means' that if $\sum a_n e^{-\lambda_n s}$ is summable $|R, \lambda, k|$ and $\sum b_n e^{-\mu_n s}$ is summable $|R, \mu, k'|$, then

$$e^{-sx}x^{-(k+k')} C_{k+k'}(x) = 0 \quad (1) \quad |C, o|$$

for all s on the line $\sigma=\sigma_2$, where $\sigma_2 > \sigma_1 \geq 0$. When k and k' are integral this has been extended to include the case $\sigma_2=\sigma_1$ by Pati (Proc. I. S. C. A., 1958).

4. M. S. RAMANUJAN (Aligarh) : *Absolute Summability of Series and Integrals.*

The necessary and sufficient conditions for a matrix to define an absolutely regular or absolutely conservative series-to-series transformation were obtained by Knopp and Lorentz who deduced from the above conditions the conditions for a matrix to define absolutely regular sequence-to-sequence transformations, obtained earlier by Mears. This enabled them to prove the absolute monotonicity of Cesàro, Hölder and Euler methods and the absolute equivalence of the first two. They also proved that an absolutely conservative (regular) sequence-to-sequence Hausdorff transformation is conservative (regular), a result proved almost at the same time by Hilda Morley. Using the general conditions of Knopp and Lorentz, I proved that for Hausdorff or quasi-Hausdorff methods, defining sequence-to-sequence or series-to-series transformations, absolute regularity implies regularity and conversely.

The close relation between Absolute regularity and the "transpose property" of a summability method has been brought out in a set of theorems proved by Vermes, and presented at the Bruxxeles Colloquium on Summability.

The algebraic structure of methods defining absolute summability which preserve convergence have been studied by Parmeswaran and he characterises the space of absolutely conservative matrices (defining series-to-series or sequence-to-sequence transformations) as a Banach algebra under a suitable normal, which result enables him to consider the nature of the inverse element, leading on to a Mercerian theorem for absolute summability.

The "summability functions" for absolute summability has been discussed by Lorentz and Macpahail. The necessary and sufficient conditions for a function to be an absolute summability function for a given method have been determined by them and in particular they have found the absolute summability functions for most of the classical methods. Yet another aspect of Lorentz's investigations is that of determining the absolute Tauberian conditions for a general method and also to show that a particular condition is the best possible absolute Tauberian condition for a chosen method. His general theory enables the deduction of the results of Hyslop (for Abel's method) and of Jurkat and Peyerimhoff (for Borel's method).

5. (KUMARI) SULAXANA KUMARI (Allahabad): *Absolute Summability of the Fourier series of a function belonging to the class $\text{Lip}(\alpha, p)$ and L^p .*

1.1. Let the Fourier series of $f(x) \in (L)$ and periodic with period 2π be,

$$f(x) \sim \frac{a_0}{2} + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx) = \frac{A_0}{2} + \sum_{n=1}^{\infty} A_n(x). \quad (1.1.1)$$

Let $\Delta = \Delta f = \Delta_h f$ denote one of the differences

$$f(x) - f(x-h), \quad f(x+h) - f(x), \quad f(x+h) - f(x-h), \quad h > 0.$$

We say that $f(x)$ belongs to the class $\text{Lip}(\alpha, p)$, if

$$\left(\int_{-\pi}^{\pi} |\Delta f|^p dx \right)^{1/p} = O(h^\alpha), \quad 0 < \alpha \leq 1, \quad p > 1.$$

It is easy to see that a function of the class $\text{Lip}(\alpha, p)$ belongs also to the class L^p . If $\Delta f = O(h^\alpha)$ then we say that $f(x)$ belongs to class $\text{Lip } \alpha$. A function of $\text{Lip } \alpha$ belongs to $\text{Lip}(\alpha, p)$ for every positive p , and the properties of such functions may be regarded as limiting cases (for $p = \infty$) of those of functions of the class $\text{Lip}(\alpha, p)$.

1.2. It was first shown by Zygmund (Journ. London Math. Soc. 3 (1928), 194-196) that if $f(x)$, periodic in $(0, 2\pi)$, is of bounded variation and also belongs to the class $\text{Lip } \alpha$, $0 < \alpha < 1$, then (1.1.1) is absolutely convergent for all values of x . When $f(x)$ merely satisfies a Lipschitz condition of order α , $0 < \alpha < 1$, then it has been proved by Bernstein (Journ. London Math. Soc. 3 (1936), 11-15), that (1.1.1) converges absolutely for all values of x provided that $\alpha > 1/2$ and not for $\alpha \leq 1/2$. Extending the above result, Hyslop (Proc. London Math. Soc. (2), 43 (1937), 475-483) has proved that if $f(x) \in \text{Lip } \alpha$, $0 < \alpha \leq 1/2$, then (1.1.1) is summable $|C, \delta|$, for $\delta > 1/2 - \alpha$. Also it has been added by Bosanquet that we cannot put $\delta = 1/2 - \alpha$ in the above result. Extending further the result of Hyslop, Chow (Proc. London Math. Soc. (2), 43 (1937), 484-489) has proved that if $f(x) \in \text{Lip}(k, p)$, for $p > 2$, $1/2 \geq k > 1/p$, then for all values of x (1.1.1) is summable $|C, \alpha|$ for every $\alpha > 1/2 - k$, and that the theorem fails for $\alpha = 1/2 - k$.

Another theorem obtained by Hardy and Littlewood (Math. Z., 28 (1928), 612-634) states that if for $1 < p \leq 2$, $k > 1/p$, $f(x) \in \text{Lip}(k, p)$, then (1.1.1) is absolutely

convergent. It being known that if $f(x)$ is of bounded variation and belongs to $\text{Lip } k$ then $f(x) \in \text{Lip } (k', p)$, $p > 1$, for $k'p = 1 + (p-1)k > 1$, the above result proves to be more far-reaching than that of Zygmund, mentioned in the beginning. Although Hardy and Littlewood stated their result in terms of the absolute convergence of Fourier series, they had substantially inferred from their hypothesis the convergence of $\sum |A_n(x)|^\gamma$, where $\gamma > p/(p+kp-1)$.

However, with the same hypothesis, a result sharper than the absolute convergence has been obtained by Chow (Journ. London Math. Soc., 17 (1942), 17-23) by proving that if for $p > 1$, $kp > 1$, $f(x) \in \text{Lip } (k, p)$ then (1.1.1) is summable $|C, \alpha|$ for $\alpha > 1/p - k$ or $\alpha > 1/2 - k$, according as $1 < p \leq 2$ or $p \geq 2$.

One of the theorems of Min Teh Cheng (Duke Math. Journ. 9 (1942), 803-810) states that if for $\alpha > 0$, $1 < p \leq 2$,

$$\int_{-\pi}^{\pi} |f(x+h) - f(x)|^p dx = O\left[h \left(\log \frac{1}{h}\right)^{-p} \left(\log_2 \frac{1}{h}\right)^{-p} \dots \left(\log_{k-1} \frac{1}{h}\right)^{-p} \left(\log_k \frac{1}{h}\right)^{-(1+\alpha p)}\right], \text{ as } h \rightarrow 0,$$

then $\sum |A_m| (\log_k |m|)^T < \infty$, for $T < \alpha + 1/p - 1$, where $\log_n(x)$ means $\log(\log_{n-1} x)$ and $\log_1 x = \log x$, and that the theorem fails for $T = \alpha + 1/p - 1$.

Some interesting results in this direction have also been obtained by Matsuyama (Tôhoku Math. Journ. 1 (1949), 40-45 and 2 (1950), 51-56).

For the Fourier series of the class L^p , $1 < p \leq 2$, it has been proved by Tsuchikura (Tôhoku Math. Journ., 5 (1954), 302-312) that if

$$\int_0^\pi \frac{|\phi(t)|^p}{t} \left(\log \frac{k}{t}\right)^\alpha dt < \infty, \text{ for } \alpha > p-1, \quad (1.2.1)$$

then (1.1.1) is summable $|C, \delta|$ for $\delta > 1/p$, at the point x . It naturally follows that the summability $|C, \delta|$, $\delta > 1/p$, of (1.1.1), when $f(x) \in L^p$, $1 < p \leq 2$, depends on local properties.

Albert Foà (Boll. un Mat. Ital. (2), 2 (1940), 325-332), Yano (Tôhoku Math. Journ. 5 (1953), 194-195) and Tsuchikura (loc. cit.) have framed examples to show that the summability $|C, 1/p|$ of the Fourier series of $f(x) \in L^p$, $1 < p \leq 2$, is not a local property.

Tsuchikura has also shown that for $p \geq 2$ summability $|C, 1/2|$ of (1.1.1) is not a local property.

Sulaxana Kumari (See abstracts, Proc. Indian Sc. Congress Assoc. (1959)) has further refined the above result by proving that even summability $|R, \log n, 1/p|$ of (1.1.1) when $f(x) \in L^p$, $1 < p \leq 2$, is not a local property. The result for the case $p > 2$ is yet to be proved.

One of the main theorems of Pati (D.Sc. Thesis, Chapter V) states that if (1.2.1) is satisfied for $k > \pi$, then, for every $\delta > 1/p$,

$$\sum n^{-\infty} \left| \int_0^\pi \left(2 \sin \frac{t}{2}\right)^\delta \sin \left\{ \left(n + \frac{\delta}{2}\right)t - \frac{1}{2}(\delta-1)\pi \right\} dt \right| < \infty.$$

It has been recently proved by Chow (Journ. London Math. Soc. 30 (1955), 439-448), that if, for $1 < p \leq 2$,

$$W_p(t) \equiv \left(\frac{1}{2\pi} \int_{-\pi}^{\pi} |f(x+t) - f(x)|^p dx \right)^{1/p} = O \left\{ \left(\log \frac{1}{|t|} \right)^{-1-\delta} \right\}, \delta > 0,$$

then (1.1.1) is summable $|C, \alpha|$, $\alpha > 1/p$, almost everywhere. Further if $W_p(t) = O \left\{ \left(\log \frac{1}{|t|} \right)^{-1-\delta} \frac{1}{p} \right\}$, $\delta > 0$, then the almost everywhere summability $|C, 1/p|$ of (1.1.1) is obtained.

Generalizing the results of some previous authors, Sulaxana Kumari (in a paper not yet published) has obtained the following result :

(A) Let $1 < p \leq 2$, $k \geq 0$, $\alpha > 0$, $1+k-\frac{1}{p}+\alpha-\beta > 0$, $R \leq p$.

If

$$\left\{ \int_0^{2\pi} |f(x+h) - f(x)|^p dx \right\}^{1/p} = O \left\{ h^k \left(\log \frac{1}{h} \right)^{-d} \right\}, d \geq 0,$$

then

$$\int_0^{2\pi} \sum \left[\left\{ n^{-1+\beta} |\tau_n^\alpha| (\log n)^d \right\}^R (\log n)^{-1-\varepsilon} \right] dx < \infty, \varepsilon > 0,$$

where $R =$

$$\begin{cases} (1+k-\frac{1}{p}+\alpha-\beta)^{-1}, & 0 < \alpha \leq \frac{1}{p}, \\ (1+k-\beta)^{-1}, & \alpha > \frac{1}{p}; \end{cases}$$

Also

$$\int_0^{2\pi} \left\{ \sum \left(n^{-1+\beta} |\tau_n^\alpha| (\log n)^d \right)^R \right\} dx < \infty,$$

for $R >$

$$\begin{cases} (1+k-\frac{1}{p}+\alpha-\beta)^{-1}, & 0 < \alpha \leq \frac{1}{p}, \\ (1+k-\beta)^{-1}, & \alpha > \frac{1}{p}, \end{cases}$$

τ_n^α being the (C, α) mean of the sequence $\{n A_n(x)\}$.

(B) Further if $\alpha = 1/p$, $1+k-\beta > 0$, and

$$\left\{ \int_0^{2\pi} |f(x+h) - g(x)|^p dx \right\}^{1/p} = O \left[h^k \left(\log \frac{1}{h} \right)^{-1-\frac{1}{p}} \left(\log \log \frac{1}{h} \right)^{-1-\varepsilon} \right], \varepsilon > 0,$$

then, for $R = (1+k-\beta)^{-1}$,

$$\int_0^{2\pi} \left(\sum |n^{-1+\beta} \xi_n^\alpha(x)|^R \right) dx < \infty.$$

The problem of finding out a best possible non-local condition, stronger than the function belonging to the class L^p , which may yield the summability $|C, 1/p|$ of (1.1.1), at a point x , is open for investigation.

II. MAGNETO HYDRODYNAMICS

Chairman: PROF. M. RAY, Agra.

1. B. R. SETH (Kharagpur): *Pinch Effect and Force-free Fields.*

A general survey of the subject of hydromagnetics has already been done by a number of authors^{1, 2, 3}. It may be worthwhile to go over some of the points in which the interaction of fluid flow with magnetic fields is of some consequence.

The study of hydromagnetics involves the use of scales of length and time which are much larger than those used in terrestrial experiments. We have to deal with magnetic fields pervading large linear dimensions for a long time. Hence we cannot expect patterns and properties deduced simply by extrapolating from terrestrial experience: for, in these instances, the scale is the essence of the phenomena, and the scale transcends terrestrial experience⁴.

The change of scale has some bright aspect. It has its disadvantages too. Let us illustrate the point with reference to the equations of continuum hydromagnetics. The equations of motion of the conducting incompressible fluid are

$$\frac{d\vec{v}}{dt} = -\frac{1}{\rho} \text{grad } p - \text{grad } u + \frac{1}{\rho} \vec{j} \times \vec{B} \quad \dots \dots \dots (1)$$

$$\text{div } \vec{v} = 0 \quad \dots \dots \dots (1a)$$

Here ρ , p , u have usual the meaning of density, pressure and gravitational potential. The last term on the right is the Lorentz force which the electromagnetic field exerts on the fluid. The behaviour of electromagnetic field is given by the usual Maxwell equations

$$\text{Curl } \vec{E} = -\frac{\partial \vec{B}}{\partial t}, \quad \text{Curl } \vec{B} = \mu \vec{j} \quad \dots \dots \dots (2)$$

$$\text{div } \vec{B} = 0 \quad \dots \dots \dots (3)$$

Now the fluid is electrically conducting (σ); on moving relative to the electromagnetic field it produces a motional induction $\vec{v} \times \vec{B}$. We can thus write the current as

$$\vec{j} = \sigma \left[\vec{E} + \vec{v} \times \vec{B} \right] \quad \dots \dots \dots (4)$$

By effecting usual elimination we obtain

$$\frac{\partial \vec{B}}{\partial t} = \text{Curl } (\vec{v} \times \vec{B}) + \gamma_m \vec{v}^2 \vec{B} \quad \dots \dots \dots (5)$$

where $\gamma_m = \frac{1}{\mu \sigma}$.

The basic equations are now given by the combined equations (1) and (5) on the assumption that μ , ρ are constant. In this derivation we have been able to drop out several terms (for example displacement current, conduction current, electrostatic effects, viscosity) simply on dimensional grounds⁵. This is a distinct advantage derived from the change of scale. At the same time change of scale makes it difficult to reproduce some of the phenomena in the laboratory. How can we then test the correctness of our equations?

Fortunately, some specific magnetic effects have been demonstrated in the laboratory which have led to increased confidence in the hydromagnetic equations. These are the 'pinch effect' and 'force-free' fields.

We have mentioned 'pinch-effect' because of its growing importance. When a very large electric current is passed through a conducting gas (plasma) in a tube, it sets up a magnetic field which tends to pinch the gas and pull it away from the wall. The magnetic lines of force circling the gas compress it by their tension. This magnetic bottle dispenses with the use of container for the plasma column. Thus in controlled fusion reaction⁶, where the main problem is to contain a very hot gas (350) million degrees for deuterium gas) within a material chamber, the pinch effect has come to our rescue.

The same type of problem arises in 'Space technology'. Pinch effect provides one of the most promising approaches for attaining the velocities and specific impulses that will be required for manned space-flight to a planet. The critical problem in attaining velocities of hundreds of thousands of miles per hour is the containment of temperatures comparable to those in the interior of stars ($\sim$ million degrees). Pinch effect provides the solution to the basic problem of containing the reaction without contact with chamber walls.

The concept of force-free fields⁷ is likely to solve the problem of production of high magnetic fields in the laboratory. These fields maintain their form through a balance of purely magnetic forces $[\mathbf{j} \times \mathbf{B} = 0]$. Let us regard the magnetic field as a gas. When we compress it i.e. when we bring the lines of magnetic force together, the pressure rises as the square of the strain of the field ($\sim B^2$). For this reason it is difficult to obtain high magnetic field in the laboratory. The immense mechanical pressure ($\sim B^2$) will lead to the rupture of coil walls. Force-free windings in a toroidal tube circumvents this difficulty. This has been proved experimentally and it is believed that fields as high as 10 million gauss may be achieved by these devices⁸.

We can raise an interesting question regarding the force-free fields. How these fields originate in Stars? Suppose the field of a magnetic star was originally in hydrostatic equilibrium with matter ($\text{grad } p = \rho \text{ grad } u + \mathbf{j} \times \mathbf{B}$). Due to internal displacement (sudden expansion or contraction) of the star the field may become force-free. This is a mere conjecture which has got to be supported by analysis. However, the question deserves attention. Recently, Chandrasekhar and Woltjer⁹ have discussed this question from a different point of view. They have shown that a system, having least dissipation of magnetic energy due to Joulean heating, may tend to force-free state.

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2. S. K. MAJUMDAR (Kharagpur) : *A Note on Force-free Magnetic Fields.*

A force-free magnetic field ($\vec{H}$) satisfies the equation

$$\text{Curl } \vec{H} = \alpha \vec{H} \quad \dots \dots \dots (1)$$

where α is a scalar point function. The manner in which such fields originate in Stellar envelopes or gaseous nebulae is an important question. Recently, Chandrasekhar and Woltjer¹ have shown that for a plasma with a finite electrical conductivity, the states with minimum dissipation (for a given magnetic energy) are the force-free states with a constant α . Woltjer² has proved that force-free fields with constant α represent the lowest state of magnetic energy which a closed system (having infinite electrical conductivity) may attain.

In this note a magneto-hydrostatic field, in an infinitely conducting incompressible liquid, is found which becomes force-free due to suitable displacement of the medium.

3. P. C. JAIN (Delhi) : *Mechanism of the Production of Small Eddies from Large Ones in the Presence of a Magnetic Field.*

As a pure hydrodynamical problem, the connection between the statistical representation of turbulence and the dissipation of energy has been discussed by G. I. Taylor [Cf. Proc. Roy. Soc. A, 151, 1935] in relation to the decay of the isotropic turbulence which is produced in a wind tunnel by means of regular grids. It has been shown there that a length λ can be defined which may be taken as a measure of the scale of the small eddies which are responsible for dissipation. Further the relation between λ and the main scale of turbulence has been given by means of three alternate formulae which are semi-empirical. These formulae represent the grinding down of large eddies into smaller ones.

In order to express these ideas in a Mathematical form, Taylor and Green [Cf. Proc. Roy. Soc. A, 153(1937)] have illustrated this fundamental process of turbulent flow in a special case by means of a mathematical model. The results so obtained cease to be valid representation of the flow when the time is too great or the Reynolds number of the flow is too high on account of the approximations used there.

In the present paper, the process of the grinding down of large eddies into smaller ones has been considered for the turbulent flow in the presence of a magnetic field by means of a mathematical model. We have taken the initial motion as given by

$$\begin{aligned} u &= A \sin ay \\ v &= A \sin az \\ w &= A \sin ax. \end{aligned}$$

We have taken the magnetic field to act parallel to one of the co-ordinate axes initially. On the basis of the assumptions that the fluid is viscous, incompressible and of infinite electrical conductivity, we have derived approximate expressions for the dissipation function and the energy. These expressions have been used to deduce further results.

¹ Chandrasekhar, S. and Woltjer, L., Proc. Nat. Acad. Sci., U.S.A., Vol. 44, No. 4 (1958).

² Woltjer, L., Proc. Nat. Acad. Sci., U.S.A., Vol. 44, No. 6 (1958).

4. S. K. CHAKRAVORTY (Calcutta) : *On the Dynamo Theory of Geomagnetic Field Variations.*

The Geomagnetic field and their variations have not been explained fully as yet. While the permanent field and its 'secular variation' is probably associated with the conditions in the interior of the earth, the variable parts of the geomagnetic field both regular and sporadic, are associated with the conditions in the ionosphere and the dynamo theory can give a reasonable explanation to the observed facts. This suggests that the magnetic field is due to electric currents induced in the ionosphere as a result of its motion across the lines of force. In the general case it would be necessary to solve the electromagnetic as well as the hydrodynamic equations simultaneously, but the underlying analysis is prohibitive, if at all possible. In a previous paper (Chakraborty & Pratap, 1954) we have discussed the problem on the assumption that the oscillations of the ionospheric layer, where the dynamo current is produced, is of the harmonic type and has a velocity potential ψ given by

$$\psi = \sum_{\sigma} \sum_{\tau} K_{\sigma}^{\tau} P_{\sigma}^{\tau} \sin (\tau t - \alpha)$$

The general solution for the current function R has been obtained and this can be evaluated for any known values of K_{σ}^{τ} . We have calculated R taking $\sigma=2$, $\tau=2$, as it is very probable that the main component in the atmospheric oscillations is a semidiurnal one. From the values of R we have derived the nature of the ring currents and also calculated the form of the Sq curves for H and V corresponding to different observatories of the world. The theoretical results compare very favourably with the results of observations.

The sporadic variations in the geomagnetic field occasionally recorded in the magnetograms as 'Solar Flares' and 'Cochet's' are possibly associated with a sudden change in the conductivity of ionospheric layer where the ring currents are produced. Such magnetic disturbances are very often connected with the 'Sunspot activity' and 'radio fade outs'. We have therefore investigated the possibility of explaining such phenomena by introducing a change in the conductivity. In a recent paper Pratap (1957) has assumed

$$\rho e = \sum f_s \cos st \exp [-\alpha S m^2 (t-t_0)]$$

where t_0 is the time of the maximum of the disturbance, and f_s is a function of the declination of the sun and also of the co-latitude of the observing station. It has been shown that with a reasonable assumption regarding the form of this change in conductivity we can well explain both the shape of the 'solar flares' recorded in magnetograms as well as their variations with the time of incidence. When more informations will be available on the dynamics of the ionospheric layers it will be possible to examine more precisely the connections between the 'Solar Emissions', 'Ionospheric disturbances' and 'Geomagnetic disturbances'.

Chakraborty, S. K. and Pratap, R., Jour. Geophys. Res., **59**, 1, 1954.

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5. J. N. KAPUR (Delhi) : *Superposability in Magnetohydrodynamics.*

The equation of magneto-hydrodynamics governing the velocity $\vec{q}$ and the magnetic field $\vec{H}$ in a fluid conductor present problems of considerable mathematical complexity. The complexity arises from the non-linearity of the equations. The non-linear terms are of three kinds: the term $(\vec{q} \cdot \nabla) \vec{q}$ and $\vec{H} \times \text{Curl } \vec{H}$ representing the inertia and the electromagnetic forces in the equation for $\vec{q}$, and the term $\vec{q} \times \vec{H}$ representing electromagnetic induction in the equation for $\vec{H}$.

In the absence of a magnetic field, there is only one non-linear term viz.

$(\vec{q} \cdot \nabla) \vec{q}$ in Navier-Stokes equations and several devices have been introduced for studying these non-linear equations. The notion of additivity or superposability is one such device that has received considerable attention during recent years.

In the present discussion, we have extended this important concept to the more general case of hydromagnetics. We have obtained the condition for superposability of two hydromagnetic motions and also the conditions for a given flow to be self-superposable. We have examined the two-dimensional and axially-symmetric flows from the point of view of superposability. As expected, the results for ordinary viscous fluid for two-dimensional flows, axially-symmetric flows with poloidal components only, and axially-symmetric flows with toroidal components as well, follow as particular cases of our results.

For hydrostatic equilibrium of magnetic stars, there is only one non-linear term viz. $(\text{curl } \vec{H}) \times \vec{H}$ and the system in which this vanishes has been studied by Chandrasekhar as the so-called force-free fields. We find that in this case, force-free fields are the same as self-superposable fields as defined by us. Moreover, we have a generalisation of these fields for hydrodynamical situations if $\vec{q}$ is not zero, but is parallel to $\vec{H}$. In fact for self-superposable fields if $\vec{H} \times \text{curl } \vec{H}$ is zero, then $(\text{curl } \vec{q}) \times \vec{q}$ has to vanish or be a gradient of a scalar function.

For $\vec{q} = 0$ again, the decay of the magnetic field is found to be governed by the diffusion equation and this has been used to estimate the period of decay of the earth's magnetic field and also for a sun-spot magnetic field. We find that for magnetohydrodynamical situations also, the same equation holds provided the field is self-superposable.

Chandrasekhar has studied the force-free fields characterised by the equation $\text{curl } \vec{H} = \alpha \vec{H}$ where α is a constant. Since $\text{div. } \vec{H} = 0$, $\vec{H}$ can be expressed in terms of two defining scalars P and T . For force-free fields, Chandrasekhar deduces

$$\alpha \text{ grad } \tilde{w}^2 P = \text{grad } \tilde{w}^2 T$$

$$\Delta_1 P = -\alpha T$$

He also deduces a further condition viz.

$$\text{grad } \tilde{w}^2 P \times \text{grad } \alpha = 0.$$

We have shown that this is not an independent condition but follows at once from the first. We have obtained an equation characterising general axially-symmetric fields and discussed some particular cases.

6. P. C. VAIDYA and B. G. PANDYA (Ahmedabad): *Rotating Spheroids of Conducting Liquids which are slightly compressible.*

Ferraro (1954) has found the small eccentricity of spheroids of conducting liquids, rotating with uniform angular velocity in the presence of magnetic fields—produced by a system of currents in the liquid. In this note the effect of introducing slight compressibility in this liquid is studied. It is found that taking the compressibility to be of the same order of smallness as the square of eccentricity

of Ferraro's spheroids, the effect of compressibility is to decrease the eccentricity and thus to bring the spheroidal form of the free surface nearer the spherical form. This effect of compressibility vanishes in the absence of either rotation or the magnetic field or both.

Though the details have been worked out for a simple approximate solution, the general equation for the isorotation of an inhomogeneous conducting liquid in the presence of the magnetic field has been derived.

III. BALLISTICS

Chairman : PROF. M. RAY, Agra.

1. DR. V. R. THIRUVENKATACHAR (Delhi) : *Perturbations of long range Ballistic Trajectories and Satellite Orbits.*

1. In the study of long range ballistic missiles, it is important to examine the effects of small changes in the position and velocity at some point in the trajectory. Such perturbations can be caused by external impulses or by errors in the position or velocity at "all burnt".

2. In the case of an artificial earth satellite the effects on its orbit of the oblateness of the earth and of the resistance of the atmosphere may be treated as perturbations of the classical elliptic orbit. For the missile trajectory, these effects are not so important but they have a significant influence on the elements of the satellite orbit. The main results in the latter case are: (i) Continued loss in apogee and perigee altitudes, these losses being oscillatory in character, (ii) a precession of the line of nodes.

3. In this note a brief discussion on the methods of calculating these perturbations and their effects is presented.

2. SHRI N. S. VENKATESAN (Delhi) : *A Note on the Internal Ballistics of Multi-tubular propellants.*

In the British system it is usual to fit a quadratic form function of the type $Z = (1-f)(1-\theta f)$ to the multi-tubular propellant also. But here, the value of $\theta = -0.172$ is determined (by the method of least squares) taking into account only the period of burning up to which slivers are formed i.e. the period during which the burning is progressive. Recently P. Tavernier has treated this problem rather exhaustively by considering the actual forms of the (Z, f) relations in the two different periods of burning and has also given tables of solution for the French system of Internal Ballistics. In this note solutions have been obtained for the British system both on the isothermal approximation and on the Hunt-Hinds method.

3. S. N. BARUA (Delhi) : *Stability of Projectiles with Liquid-filled Cavities.*

The stability of rotating projectiles is analogous to the stability of tops provided the curvature of the trajectory is sufficiently small, near the muzzle of a gun. On this basis the stability of liquid-filled projectiles has been studied and the conclusions have been verified experimentally by observing the motion of liquid-filled tops under laboratory conditions. It has been found that the behaviour of projectiles undergoes considerable modification in the presence of liquid-filled cavities; they exhibit some traits which are not common to solid projectiles. The dependence of stability on various parameters involved has been studied in detail

for projectiles with symmetrical (about the axis) spheroidal cavities completely filled with liquid. As a particular case the stability of projectiles for which the resultant thrust of the medium passes through the centre of gravity has also been considered.

4. J. N. KAPUR (Delhi) : *Integration of the Equations of Internal Ballistics for Pressure—Index Law of Burning.*

The law of burning most commonly used in Internal Ballistics of guns and rockets is Vieilles Law :

$$\text{Law I} \quad B(p) = B p^{\alpha}$$

where the pressure-index α lies between 0.9 and 1.1 for the high pressure in guns and between 0.3 and 0.8 for the comparatively lower pressures in rocket motors. Accordingly, for convenience in analytic solutions of the equations of Internal Ballistics of guns, Law I is replaced by :

$$\begin{aligned} \text{Law II} \quad B(p) &= B' p \\ \text{with} \quad B' &= B - \frac{1}{10} B (10\alpha + 9) (1 - \alpha) \end{aligned}$$

Solutions for Law II have been given by Crow (1922), Sugot (1928), Hunt and Hinds (1929), Coppock (1942), Goldie (1945), Billiard (1948) and are described in detail in the H.M.S.O. publication 'Internal Ballistics' (1951) and in Corner's book (1950).

It is necessary, however, to obtain the solution for Law I, which is found more plausible on the basis of observations in order to check the accuracy of the results obtained with Law II, and to see what special alterations should be made if one wishes to use the simplified Law II instead of Law I. The study of the solutions for the power law would also be useful in the study of the Internal Ballistics of solid fuel rockets, recoil-less guns, and high-low guns where Law II would not be even a good approximation.

Clemmow (1928, 1951) solved the system of equations of Internal Ballistics for Law I in terms of the solution of an ordinary non-linear differential equation of order three, in the general case, and of order two, in the special case of a tubular charge. Later Kapur (1957) obtained the solution in terms of the solution of a non-linear differential equation of order two, even in the general case. This was achieved by a suitable choice of the variables and in fact the system admitted a number of such choices and these were worked out systematically by Kapur (1957). Kapur (1957) also gave the solution of the resulting differential equations under the appropriate initial conditions, for the isothermal model, for the specific case of a tubular propellant. The solution was obtained for the case of gun in the form of a series in powers of $1 - \alpha$. This was warranted, as for most of the propellants, $1 - \alpha$ lies between -0.1 and 0.1. Later Kapur (1958a) extended his numerical results to include the coefficient of $(1 - \alpha)^2$ and deduced the effects of the departure of α from unity on maximum pressure, all-burnt position and muzzle velocity etc.

Clemmow's methods were applicable only to the case β less than unity and so in 1956, he extended his earlier methods to include the case when α could be greater than unity. This was, of course, necessitated by the designing of certain new propellants in the intervening period for which α was greater than unity. Kapur's methods were applicable to both α less and greater than unity and no such extension was, therefore, necessary. However, for α greater unity, Kapur (1958b) has obtained certain exact solutions, which enable us to get some insight into the effects on internal ballistics of α being greater than unity.

In his 1928 paper, Clemmow had published his numerical solution for $\alpha = 1/2$ for the isothermal model. In 1956, Clemmow published further solutions for other values of α , but only for isothermal model.

To investigate the problem completely, it was necessary to integrate the non-linear differential equations for the non-isothermal model for the pressure-index law for a typical range of values of initial conditions and parameters. On behalf of the author, Dr. M. K. Jain did extensive numerical computations on an electronic computer at Hamburg. These computations would take considerable time to be finally put in the form of extensive tables for practical use, but in the present report, the first results obtained so far are being reported.

5. G. C. PATNI (Jaipur) : *The Motion of a Spinning Projectile about its Centre of Gravity.*

The motion of a spinning projectile about its centre of gravity is a very complicated phenomenon. With a view to getting a tangible solution, various authors have made different assumptions, firstly, with regard to the system of aerodynamic and other forces acting on the projectile and, secondly, for the solution of the differential equations occurring in the problem. Mostly the system of forces as given by English authors is adopted by other authors also. In 1920, Fowler, Gallop, Lock and Richmond jointly published a paper 'The Aerodynamics of a Spinning Shell's in the Philosophical Transactions of the Royal Society of London in which they gave for the first time a very comprehensive, detailed, theoretical and experimental account of the force system acting on a spinning projectile. This paper has proved to be of immense importance in the study of External Ballistics. Most of the researches in modern External Ballistics have centred about this classical and basic paper.

Nielson and Synge (1946) have, however, criticised the theory of Fowler et al. for a logical contradiction; they have shown that the force system of Fowler et al. is not the most general system consistent with the aerodynamic hypothesis as it does not satisfy the fundamental requirements of invariance w.r.t. the shift of mass centre and may lead to such conclusions as $1=0$. But Nielson and Synge have themselves admitted that in spite of this defect, the theory of Fowler etc. is mathematically more satisfactory than their own and that the logical contradiction does not invalidate the physical conclusions arrived in practice on the basis of the theory of Fowler.

Pioneer work on this subject has been done in France, Germany, Russia and America also, but unfortunately in our country India, very little work has been done on this subject. The first paper published by an Indian is that published in French journal, *Memorial de l' Artillerie française* Tome 31, 4^e fasc., 1957. In this paper, the author—Patni—has generalised and extended the results of Darpas (1953), Lichnerowicz (1940) and Hecq (1937) published in the same journal. The generalisation is affected by including some additional terms and factors, regarding the Magnus force, the damping couple and the cross-wind force, though small magnitudes, which have been neglected by these authors. The effects of these terms on the initial mutations and on the stability of motion of a rotating projectile and other allied quantities have been discussed and it has been shown that, in particular, the effect of including the Magnus force coefficient is to decrease the optimum value of the stability factor.

6. B. S. MADHAVA RAO (Poona) : *General Relativity and Earth Satellites.*

The purpose of this note is to examine if suitable observations of earth satellites could be devised so as to provide tests for Einstein's general theory of relativity. At first sight, such an attempt may appear to be of purely theoretical interest, not worth undertaking, while there are more urgent uses of practical importance await-

ing investigation. Thus, one could consider the role of satellites, and in particular, of inter-continental ballistic missiles in warfare. Even as regards scientific uses, observations of atmospheric, ionospheric, radio emission, solar and interplanetary phenomena over a wide range of longitude and latitude for periods of weeks or more appear to be of great practical interest. But, as the history of Science has unmistakably shown, results of practical importance stem quite naturally as consequences of new physical theories of fundamental importance, as for example, Maxwell's theory leading to Electronics, Quantum Mechanics leading to superconductivity, and to transistors, nuclear physics to nuclear power, and so on. Hence it is quite important that one should exploit this innovation of earth satellites and their further developments to test existing physical theories, and thereby deduce new theories of fundamental significance.

Of the existing theories which need immediate testing by experiments, the general theory of relativity would be a natural choice because the experimental tests are so few, and have to be conducted at the macroscopic level. In fact, the only three tests so far suggested are of an astronomical nature, and relate to the measurements of (1) the advance of the perihelion of Mercury, (2) the gravitational deflection of light rays, and (3) the gravitational deflection of spectral lines. Of these, it is well-known that (1) and (2) are not entirely crucial tests of Einstein's theory, since there are other theories differing from it in major respects but giving the same results in these two cases. Even (3) is not such a crucial

test, for, the gravitational red shift given, in the usual notation, by $\frac{\Delta\lambda}{\lambda} = \frac{GM}{rc^2}$, can also be derived if one assumes that the photon has mass given by $m = \frac{\hbar}{\lambda c}$, and also that the potential V is the ordinary Newtonian gravitational potential given by $V = -\frac{GM}{r}$. The reddening of the spectral lines can then be viewed as the loss of energy by photons as they leave the region of high gravitational potential.

These considerations speak strongly for additional tests of the general theory of relativity. One such test using artificial satellites which suggests itself naturally is to compare time intervals as shown by two physically identical clocks, one located on the earth's surface, and the other in the satellite, as observed by an observer far away from the earth. For such an observer the proper time interval ds of the clock at his location is exactly equal to his co-ordinate time interval dt , and using the Schwarzschild line element of the general theory of relativity it is possible to calculate the relation between ds and dt_e (time interval as shown by the clock on the earth), and between ds and dt_s (time interval as shown by the clock on the satellite), and hence obtain a relation connecting dt_e and dt_s . Assuming a circular orbit for satellite with radius $r = h + R_e$, where R_e is the earth's radius, one can derive an expression for the shift Δ experienced by the clock on the satellite relative to the one on the earth in the form

$$\Delta = \frac{dt_s - dt_e}{dt_e} \sim 7 \times 10^{-10} \left\{ \frac{1.5}{1 + (h/R_e)} - 1 \right\}.$$

This expression shows that the satellite clock runs slower than the earth clock if the satellite altitude $h < \frac{1}{2}R_e$, and runs faster if $h > \frac{1}{2}R_e$. Also the effect is appreciably large and therefore conceivably subject to observation. Calculations can be carried out for highly elliptical satellite orbits also, and show that such orbits are more advantageous than circular ones from the point of view of observation of the shift.

It should be remarked, however, that even if such an experimental test as the above could be made by using suitable atomic clocks and accurate signals used to

exchange information, and a positive result obtained, one cannot consider the general theory of relativity as having been completely verified, and given a firm physical foundation. The reason is that the above expression for Δ can also be deduced on the basis of the special relativity theory alone. In fact, observations involving earth satellites which cannot be explained on the basis of the special theory alone, but require the general theory have so far not been suggested.

The essential reason for the existence of such a situation appears to be the fact that the general theory of relativity itself has not been fully developed, and brought into close relationship with other existing physical theories, as for example, quantum mechanics. The very fundamental notions of the general theory like covariance, uniformity, and equivalence have not been properly clarified, and this has resulted in the existence of many theories of relativity besides Einstein's. There has recently been a great awakening of interest in general relativity in the last few years, and attempts have been made to develop it from many points of view. At the microscopic level, these attempts are directed towards bringing general relativity and quantum mechanics closer together, and to build up a satisfactory quantum theory of gravitation by modifying, if necessary, the principles of quantum mechanics itself so as to explain the extremely weak nature of gravitational interaction. At the macroscopic level, cosmological problems which arise naturally out of general relativity are being thoroughly investigated to find out if they lead to facts which can be tested by devising astronomical observations made possible by elaborate equipment assembled by sputniks in interplanetary space.

7. S. P. AGGARWAL (Poona) : *Life times of artificial earth satellites.*

"Conditions under which lifetime in an elliptic orbit is a minimum and lifetime in a circular orbit is maximum with the total lifetime being maximised. Effects on these lifetimes due to oblateness of the Earth".

Introduction :

One of the most important aspects of Satellite engineering is the determination or prediction of the duration of the satellite on its orbit under given initial condition. Next comes the problem of maximising this lifetime for those conditions.

From observational point of view the circular path is the most desirable one, since the satellite travels at a constant height above all observing sites and comparable position measurements could be correlated directly. Thus in this article the aim is to minimise the lifetime in an elliptic orbit and to maximise the lifetime in a circular orbit with the total lifetime being maximised.

The determination of the lifetime of a satellite is directly connected with the atmospheric drag. On the other hand the effect of air drag on satellite orbits is rather difficult to analyse due to (i) uncertainty as to atmospheric density at extreme altitudes, (ii) uncertainty about a correct drag law and drag co-efficient for a body passing through a rarefied gas with extreme high velocity, and (iii) difficulty of solving the non-linear differential equations of motion.

However for the purpose of this article we will assume that the atmospheric mass density is given by,

$$\rho(h) = K e^{-h/c} = K e^{-(v/R)^2}$$

where h is the height above the surface of the earth, R is the radius of earth, and K & C are constants. This functional relationship is quite close to the truth for values of H between 150 and 800 km. Experimental data have become available and the tables have been prepared. (Atmospheric Rocket Research Panel). The data indicates that we should take,

$$K = 7.7 \times 10^{-6} \text{ gm/cm}^3$$

$$C = 23.3 \text{ km} = 2.33 \times 10^6 \text{ cm.}$$

That the drag is caused by individual molecular impacts and is calculable from kinetic theory.

Thus the drag of the satellite, $D = \frac{1}{2} C_D \rho A v^2$. And the drag co-efficient is $C_D = 2$.

Description of the Motion :

Usually the satellite will start life in an elliptic orbit and gradually it will become almost circular and will assume the form of a spiral. This form persists until the satellite is destroyed in the lower atmosphere. If the variation in height around the orbit is large then the drag will have a sharp maximum at the perigee. The motion will be very much as if satellite suffered impulsive losses of velocity on each passage of the perigee. Thus the perigee will remain almost constant, while the apogee diminishes at each revolution. There will also be a slow rotation of the major axis but this is a higher order effect. Paradoxically the effect of drag will be to increase the mean velocity of the satellite. The form of the orbit is always close to that of a dragless orbit, but it is well known that nearer a satellite is to its parent body the higher is its speed. In descending the satellite converts potential energy to kinetic energy. Only part of this P.E. is used to overcome drag, the remainder appears in the form of increased mean velocity.

Lifetime in a Circular Orbit :

The determination of the lifetime is based on the equilibrium that exists at all times between the kinetic, potential and drag energies i.e.

Decrease in P.E. = Increase in K.E. + Energy used in overcoming the drag.

Irvin G. Henry¹ has shown that, considering the simple gravitational potential,

$$V = -\frac{G_0 M_0 m}{R} - \frac{R}{r} \quad \text{where } G_0 = \text{the universal gravitational constant,} \\ M_0 = \text{the mass of the earth}$$

$$\equiv -\frac{MGR^2}{r} \quad (G = \frac{G_0 M_0}{R^2} \text{ i.e. the gravitational accel. at the surface of the earth})$$

a satellite will execute in a circular the number of turns given by,

$$(n_2 - n_1) = \frac{1}{4\pi} \left(\frac{C}{R^2 k} \right) \frac{M}{A} e^{q/c} \left[1 - \frac{2q}{R} \right] \\ \equiv \frac{1}{4\pi} \left(\frac{C}{R^2 k} \right) \left(\frac{M}{A} \right) e^{(p-R)/c} \left(\frac{R}{p} \right)^2 \quad \text{where } p = R + q$$

$$\frac{M}{A} = \text{mass per frontal area of the satellite (gm/cm}^2\text{)}.$$

The life time in an elliptic orbit is given by,

$$n_1 = \frac{1}{4\pi} \left(\frac{C}{R^2 k} \right) \frac{M}{A} e^{(p-R)/c} \left(\frac{R}{p} \right)^2 \left[2 - \left(\frac{\sqrt{2\pi}}{3} \right) \left(\frac{G}{c} \right)^{3/2} \right]$$

The total number of turns executed is thus,

$$n_2 = \text{Nos. of turn in circular orbit} + \text{Nos. of turns in elliptic orbit.}$$

Minimising the Total Lifetime.

In general the satellite will usually spend greater part of its life in the elliptic orbit. However the usual situation is that a given energy is available for launching the satellite and this implies that a fixed $(p+a)$ is attainable. If maximum lifetime

is required by the satellite then, a , should be as small as possible while, p , is made as large as possible, that is the satellite should be launched in a circular orbit.

The Effect of Oblateness of Earth on the Period of Satellite.

We have considered here a more general case of gravitational potential given by Jeffrey which describes the earth's oblateness in terms of a latitude-dependent function as,

$$V(r, \theta) = -\frac{G_0 M_0}{R} \left\{ \frac{R}{r} + J \frac{R^2}{r^3} (1 - \cos^2 \theta) + \frac{D}{35} \frac{R^5}{r^5} (35 \cos^4 \theta - 30 \cos^2 \theta + 3) \right\}$$

Taking account of this potential function the number of turns executed by a satellite in the circular orbit in the equatorial plane are given by,

$$(n_2 - n_1) = \frac{M}{4\pi AR^2(1+J)K} C e^{q/c} \left[1 - \frac{2q}{R(1+J)} \right],$$

and for an orbit in the polar plane the number of turns executed are,

$$(n_2 - n_1) = \frac{M}{4\pi AR^2 \left(1 - \frac{J}{2}\right) k} C e^{q/c} \left[1 - \frac{2q}{R \left(1 - \frac{J}{2}\right)} \right]$$

It is clear from the above two expressions that for an orbit in the equatorial plane the effect of oblateness of the earth is to reduce the number of turns in the circular part of the motion, and for an orbit in the polar plane the number of turns in the circular part of motion is greater and the excess over the case of a spherical earth is about half the defect for equatorial case.

Thus the maximum lifetime of a satellite will be achieved if it is projected in a circular orbit in the polar plane.

The effect of oblateness on the time period of a satellite can be easily understood physically. For near equatorial orbits at a fixed distance r_0 , the potential is constant and equal to

$$V = -\frac{G_0 M_0}{r_0} \left(1 + \frac{J R^2}{3 r_0^2} \right)$$

That is the effect of equatorial bulge is to increase the gravitational potential and the attractive force on the satellite. To maintain the fixed distances the mean speed of the satellite must be increased and the period reduced.

For near-polar orbits the potential varies with latitude. However for a fixed distance V_0 , the potential is,

$$V = -\frac{G_0 M_0}{r_0} \left(1 - \left(\frac{J R^2}{6 r_0^2} \right) \right)$$

In other words for such orbits the effect of the earth's equatorial bulge is to reduce the average potential and force on the satellite. To maintain the fixed distance the mean speed of the satellite is decreased and hence the orbit period is increased.

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8. S. KRISHNA (Poona) : *Optimum rocket trajectories.*

Fried and Richardson (J. App. Phys., 27, p. 955, 1957) have obtained the result that, under suitable assumptions, the maximum range trajectory of a single rocket is the one for which the thrust direction is fixed in space throughout the powered flight. It is investigated here whether it is possible to generalise this result to the case of multi-stage rockets.

I. ROLE OF OPERATIONAL RESEARCH IN PLANNING

Section of Statistics

Chairman: PROF. A. BHATTACHARYYA, Calcutta.

1. V. G. PANSE (New Delhi).

Operational research is not a new science but a mode of approach or a philosophy which underlines the strictly practical aims of research. It is the application of scientific method to detect and solve problems that must be tackled in order to improve the efficiency of productivity of an organization. In the context of planning for increasing industrial and agricultural production, promotion of operational research will be invaluable, but we must begin by confining our attention to the strictly practical problems of planning and execution. Various theoretical developments like queuing theory, information theory, programming, use of Monte Carlo procedures of generating distributions have taken place in the course of attempts to solve strictly practical problems in specific fields, which face operational research workers in other countries, and I hope that we shall not mistake these developments themselves as being operational research. The only field in which anything like operational research is being tried in our country is quality control in industry, but the most urgent need is the application of operational research to our greatest industry, namely, agriculture. This involves assembling together available data from surveys and experimental research, arranging for collection of additional data, where gaps exist, analysing the data with reference to economic and technological considerations and providing extension workers with appropriate plan of action. This calls for team work by statisticians, economists and technologists. The need for such work was illustrated with reference to the programme of irrigation. Two small examples of the application of operational research in the countrywide campaign for eradication of rinder pest among cattle were also given. These included the optimum size of field parties for maximum rate of inoculation and the optimum quantities of the rinder pest vaccine to be packed in ampoules.

2. H. S. SUBBA RAO (New Delhi).

Operational Research is applicable in study of repetitive operations with a view to improve the methods and techniques. Planning on a national scale involves taking certain risks and setting up objectives which are interdependent and the failure or success of the plan depends on how far we achieve the objectives.

Operational Research can be successful only in fields with limited objectives involving as few parameters as possible whose values are more or less well defined and known. As such Operational Research can play a useful role in specified fields and activities forming part of the larger plan and thus contribute to the success of the plan.

3. J. SANDEE, United Nations Technical Assistance Expert : *Industrial growth in the Third Five Year Plan.*

Assuming Rs. 10,000 crores to be the investment during the Third Five Year Plan, about 2,500 crores can be spent on manufacturing (excluding power).

The steel, engineering, chemical, fertiliser and paper industries will be called upon to save imports to keep the balance of payments in order. The other industries, which do not substitute imports (by their nature) will have to make so with whatever capital is available to them. If we assume exports to rise by 150 crores during the Plan, and imports of non-substitutable commodities (such as mineral oils or copper) to rise by 150 crores. and if we assume the balance of services and capital not to change much, the imports of substitutable products are not allowed to rise.

We can now draw up the following balances :

Origin :		1960	1965	Destinations :		1960	1965
Output	...	400	1,000	Investment	...	550	850†
Imports	...	500	500	Use in import subst. industries	...	100	200
				„ „ other industries	...	150	200†
				„ „ agriculture (fertiliser)	...	80	200*
				Stocks	...	20	50
		900	1,500			900	1,500

* Maximum that can be taken up.

† Assuming those industries to expand by about 40 per cent.

‡ Rise proportional to growth in investment from Second to Third Five-Year Plans.

With a capital-output ratio of 3:1, the investment needed in this sector to expand output from 400 to 1,000 crores will be 1,800 crores.

This leaves 700 crores for all other manufacturing. As the capital-output ratio in those industries is $1\frac{1}{2}$:1, the capacity can grow by 1,050 crores. Besides, there is unused capacity.

Output in 1960 may be 2,600 crores, and a rise of at least 1,050 crores means 40 per cent. Consumption of industrial products might thus rise by 40 per cent at least.

The largest technical problem before planners may well be how to make food supply keep up with industrial output.

The most difficult overall problem is, of course, where to find Rs. 10,000 crores.

4. DR. K. S. RAO (New Delhi) :

I myself cannot pretend to give any precise definition of operational research, but we have been engaged on the application of scientific methods to the solution of problems connected with our work. In operational economics, the models are so formulated as to enable the linking up of instrumental variables with target variables so as to facilitate operation. In econometric models the social framework, technique, etc., are taken as given and the work of economic system is studied by means of these models. But in planning not only the re-arrangement of the economic variables, but also a re-adjustment of the social, technological and other parameters will have to have a large part to play in the optimum allocation of resources and the speediest possible development of the economy. Thus, opera-

tional models based simultaneously on social, technological and economic variables are essential for economic planning.

I shall illustrate the above by means of an example. In the operation of increasing rice production, the effort needed will have to be distributed between the various districts in such a way that the overall production is the largest. The administrative effort and other resources, fertilizer, credit, etc., which the planning authority can allocate between the various districts will necessitate a complementary re-adjustment of resources and administration in a district so as to maximize the output necessary. Thus, for every set of inputs by the planning authority, there is a certain increase in output which we may call output resulting from the inputs. After re-adjustment of effort and resources in the district is made to the extent possible, if a limited amount of these inputs is available to the planning authority, the question of their distribution among the various districts is to be tackled by techniques such as linear programming in order to maximize the net addition to the production. The technique is illustrated by means of the example of distribution of fertilizer as between the various rice growing districts to maximize rice output.

5. K. C. SEAL (New Delhi) :

In Operations Research certain recurrent classes of problems involving mainly the following five processes : inventory, allocations, waiting-time, replacement and competitive, usually arise. To indicate briefly how Operations Research may become useful in Health Planning, I shall mention at first how allocation problem is encountered. Health standard depends on so many factors that it is extremely difficult, if not impossible, to mention all of them. However, some among these factors may be considered as very important due to the fact that deficiency in any one of these major factors will vitally affect the health of the people, no matter how advanced the locality may be in other major factors. One of the problems in health planning for the country is how to allocate the available resources between the above factors so as to achieve highest rate of improvement in the standard of health. Evidently more stress should be given on those important factors in which the prevailing condition is decidedly bad. As such an order of priority should be set up between these major factors. This order may vary from region to region and may change with time. But depending on the magnitude of the problem in various regions some order of priority can be arrived at that will be valid for the entire country. The next question as may be put is what is the optimum rate of improvement of each of these factors under the available resources. Clearly the improvement to the envisaged on any one of these factors should be such that there is no imbalance between demand and supply of the facilities that may be required for the anticipated achievement. It is not difficult to see that this problem of optimum allocation between the major factors when the available resources are limited can be solved through some techniques of mathematical programming, linear or quadratic or some related procedure like activity analysis.

Real system, however, is usually a combined process and it seldom involves only one of the five processes mentioned above; for example, the aforesaid allocation problem really includes some other processes also. Family Planning clinics involve staffing the family planning clinics or hospitals and the problem then arises how many doctors, nurses, midwives etc., will be required at different times. This problem is then included under an inventory process. Again provision of doctors or nurses as well as construction of family planning clinics or hospitals require certain period of time and it varies for different categories of personnel or the type of constructions. So, proper balancing of demand and supply of medical and health personnel that is required under the allocation problem cited

above will require solution of a waiting-time process. Further the doctors, nurses and other health personnel are not going to remain for ever in service. When should replacement of different categories of personnel take place? Owing to shortage of doctors or nurses at present should the retirement age be raised, if so, by how much? This problem then comes under the replacement process.

6. MAHESH CHAND.

Operational Research in a sense has been going on ever since industrial revolution as we got to complex methods of production and larger scales of production. There has been a growing need for optimum decisions for the firm as a whole as against sub-optimum decisions. It calls for team-approach by different experts and sectional (or departmental) heads. But we got the new label since 1942 from military departments. The application got on to industries, faster in U.K. first and later in U.S.A. Now we are thinking of operation research in the background of macro-economics. Mr. Sandee tried to show how by a little cool calculations we can arrive at future hurdles and requirements which are necessary to make us realise the need for greater sacrifices. Dr. Sen has however drawn attention to the various stages—the formulation of a problem, the making of a mathematical model of the type $E=f(x, y)$, the fitting of models, the controls, the tests and implementation. I would underline the features of x and y . If x is the control-variable, y is an uncontrollable variable and changes in its value may wreck planning and call for readjustments entailing great sacrifices.

I would also like to emphasize the need for Operation Research at the field and the firm levels. Macro-plans are ultimately sum total of micro-plans sent up from the stage of villages, tehsils, districts and States. Operation Research at the lowest level will not only ensure efficiency in implementation but also efficiency in regard to the models for the next plan. Take for instance, the capital-output ratio assumed. A higher capital-output ratio shall mean greater than necessary sacrifices. An unnecessary capital output ratio (as perhaps has happened in regard to agriculture in the SFYP) may lead to non-fulfilment of targets. Hence the need for O.R. at the micro-levels.

There is another point. Sometimes old contents with new labels gives a better incentive—a new start—a new outlook and team spirit. May be O.R. will lead our statisticians, scientists, psychologists, engineers and economists to co-operate to a greater extent.

7. DR. AMODE RANJAN SEN, Cinnamara, Assam.

1. Dr. Sen said he would like to use the definition of operational research "as the combined application of observations, experiment and reasoning to problems arising in administration and planning". He illustrated his point by referring to problems in the tea-industry of North East India.

2. Dr. Sen said one of the present problems in the production sector of the economy is to find ways and means of maximising for a given cost production volume without affecting quality.

3. The potentialities of the production sector of the industry has been masked by restriction schemes affecting both permissible export quotas and agricultural techniques *e.g.*, through the limitation of fertilizer supplies; it is likely that supply of fertilizers in future years may be substantially curtailed. Operational research in this sector is being undertaken by:

- (i) having a series of co-ordinated experiments spread over the various regions to obtain input-output data on response curve;

(ii) collection of fresh data from records and books kept by garden managers through surveys and making use of data gathered in other fields of work;

(iii) summarisation of past data—careful and accurate classification of facts and their correlation.

4. To throw light on the prevalence and seriousness of pests and diseases a sample survey has been initiated on a pilot scale in two neighbouring tea districts. The survey data are being collected from gardens to investigate the survey techniques and assess the value of the data obtained. The sampling design is two-stage, tea gardens as first stage units and affected sections as second stage units. The experience on questionnaire, design, method of collection of data and operational set up gathered from the pilot survey will be utilized in planning future surveys on a large scale.

5. Dr. Sen finally discussed the problem of intermittent plucking in experimentation for labour economy and the role of linear programming in apportioning a given area under tea to a given number of pruning cycles such that the over-all yield of the garden is maximised.

Dr. S. R. Sen, New Delhi and Mr. K. C. Basak, Calcutta also participated in the symposium.

II. 1961 POPULATION CENSUS OF INDIA

Chairman : PROF. A. BHATTACHARYYA, Calcutta.

1. ASOKE MITRA, New Delhi.

Ever since 1881 the range of enquiries, demographic and economic, in Indian census, has been fairly uniform, thus facilitating comparability of data, although economic definitions and concepts have changed from census to census. Contrary to popular notion that the census before 1951 was mainly preoccupied with religion, caste and tribe, on which a distinguished corpus of literature has indeed been contributed by the census, the census was also concerned from an early stage with economic classification. It will perhaps come as a surprise to many persons that a very acceptable classification suited to subsistence economy was developed as early as 1891 and perfected in 1901, which however was practically abandoned in 1911 in favour of international comparability.

The Indian census suffers from a number of disadvantages that can also be regarded as advantages. Enumeration is still honorary, done by about a million enumerators drawn from all walks of life. While this affects quality to a certain degree, because of lack of training and the variety of background from which they are drawn, the census assumes the character of a national undertaking and bestows a spirit of dedication. The difficulties of organising a census are counterbalanced to some degree by nation-wide publicity and the requisitioning for a short period of almost the entire administrative machinery. Intimate local knowledge of enumerators can be both an advantage and a disadvantage for obvious reasons. On the other hand, the census is held with respect by all shades of opinion as a standard impartial enquiry which can be an effective tool in the hands of any body, for or against the Government.

The two Five Year Plans and the Third Plan have imposed certain responsibilities on the census. Firstly, migration and urbanisation demand to be studied more closely than ever before. For this purpose, more questions need to be put on migration and the definition of urbanisation needs to be made uniform. Secondly, housing conditions need to be studied in greater detail and the results, however brief, need to be published. Thirdly, while mother-tongue will always be

recorded strictly as returned by the citizen, no matter whether the return is correct or not, there should be an attempt to classify the returns properly so as to weed out, at the tabulation and publication stage, dialects, local synonyms of real names and spurious names. Fourthly, the forthcoming census should be able to meet, to some extent, the growing demand for cross-tabulation of the standard tables, especially the economic tables, by at least seven age groups, sex and broad educational categories. Fifthly, on the threshold of a large-scale programme of industrialisation, the next census should present two economic tables, one of occupational, the other of industrial classification. The occupational classification should preferably be in two parts, one showing traditional skills of artisans and craftsmen, and the other modern skills, so that the two parts together may adequately reflect the problem of conversion of skills in certain sectors. The industrial classification should be able to show the extent of handicrafts in home industries, the sector occupied by industries organised outside of home but not entering the orbit of Factories Registration Act and the organised industries' sector covered by the Factories Registration Act.

Since more than 70 per cent of India's population is still embedded in subsistence economy in which the household works primarily as a consuming and producing unit, engaged neither in payment nor profit or gainful employment, it is proposed to study certain economic characteristics of the household as such. For this purpose, two sets of questions would be addressed to the household : one on land and the other on household industries. These will include questions on the number of family workers and hired workers employed, a short analysis of land cultivated, the nature of the household industry or business, the number of months during the year in which they are undertaken, the number of family and hired workers employed. This household schedule would be preserved in the form of bound books for the village as a whole and will provide the frame for all subsequent sample enquiries. As can be imagined, an attempt will be made to assess the contribution of the family worker in our economy.

2. DR. S. S. ZARKOVICH (Jugoslavia) :

The first point that I would like to comment on concerns the yesterday's alternative : local enumerators or externally recruited staff. The alternative is not a real one because the use of outside people requires transportation costs and per diem which rules out the idea of employing non-local staff.

Among the topics that should be included on the programme of census pre-testing are the following.

(i) *Completeness of enumeration* for the obvious reason that the best census material gives a based picture if incomplete. This check has to show what degree of completeness can be expected and what are the sources of failures. The latter makes it possible to call enumerators' attention to some particular difficulties, prepare better instructions, improve the mapping material etc.

(ii) *Expected accuracy*, which is checked with the aim of determining what is the magnitude of biases that can be expected on various census questions as well as the response errors connected with these biases. If this information is available one has the guidance on deciding of what to do with the census programme, what items should be retained on the complete enumeration census, what should be obtained in a sample basis and what question should be preferably dropped out altogether. Such a study can lead to both savings and considerable improvement of accuracy in census information.

(iii) *Amount of training to be given to enumerators*, which can be studied by comparing the performance and accuracy achievements of the regular census enumerators with the corresponding results obtained by some better and longer trained

personnel. If there is any significant difference it can be used as a basis for a speculation on what should be done and whether some more training will be embarked upon.

(iv) *Enumerators' contribution to errors in census results*, which is usually checked with the aim of ascertaining the amount of errors that the enumerators introduce into census results by influencing the information collected. As I understand, the enumeration districts in India are rather large in terms of the number of people and this is just the situation here this problem has a particular importance. On the other hand, the draft of the programme proposed emphasises economic characteristics which is exactly the field where enumerators can be expected to deteriorate seriously the quality of the census material.

(v) *Obtaining guidance for processing*. In absence of any knowledge as to the quality of the material to be processed, quality criteria to be imposed on various phases of processing are not based on facts and are often misleading; there are examples showing that a rather poor incoming material was processed by observing sharp quality criteria and vice versa. To avoid such cases and bring our operations into agreement with modern principles of rationalisation, relevant facts as to what decisions should be made with respect to processing have to be collected beforehand.

The methodology of such checks is a quite different problem. It was pointed out that over-lapping could be used with the aim of getting independent data on the same units without letting the enumerators know that their proof is being subject to a control. In my opinion, this idea can be easily applied in area statistics where any number of enumerators can be used to get an independent information on something that is the same in all attempts. In a census of population the first investigator provokes a conditioning effect and the person involved may not be the same at the second attempt. It does not mean complete pessimism although it requires correction.

I would also like to call attention to the models that are used in such testing. In most of the work done so far this problem was neglected. Some models can be easily developed but the final formulas contain terms that cannot be estimated. It requires a number of approximations where mistakes can be easily introduced. This is again a problem that requires very clear thinking before any field work is started.

May I also touch the question of the government. It was pointed out that government do not give money for studies. I am of the opinion that responsible persons in the government should be explained clearly that refusing to give money for studies aimed at finding the most rational type of census methodology means a very non-economical spending money at later stages where an improperly prepared census is already started.

3. P. K. PANI (Bombay) :

I have just a point to mention about the question of identifying unpaid family workers. Some of the activities done as household work in undeveloped countries are done on an industry basis in advanced money economies. It appears therefore necessary to draw up a list of household activities which by conversion would be regarded as genuine house hold work for consumption purposes. Thus in India as it is in other undeveloped countries a substantial number of persons who work inside households who are partly and fully occupied in any of the activities which are considered as "self help domestic industries" should be considered as part of economically active persons. Thus enumeration of unpaid labour in under-developed countries will bring in first a clear definition of what a self help domestic industry is and a complete listing of the same and secondly a definition of unpaid activities outside the household.

4. DR. S. N. AGARWALA, New Delhi.

I take this opportunity to emphasise few points which are concerned with the census operation and which, though general, have bearing on the 1961 Census.

1. The Indian census is one of the biggest operations in the world. For such a big operation, a big organisation is needed. Unfortunately, the Census Commissioner does not have an adequate permanent staff. Although, the post of the Census Commissioner was made permanent in 1947, it was only about nine months ago that a full-time Census Commissioner was appointed. Some learned speakers before me had stressed the need of pilot surveys. This is very well. But how is this possible unless the Census Commissioner begins to plan for the new census four to five years ahead of the Census? This deficiency not only results in hurried planning for new census, it does not leave much time for exploratory surveys. On this the Census Commissioner has no control. If given sufficient time and resources, I am sure, the Census Commissioner will be only too glad to conduct exploratory surveys.

2. India has the biggest illiterate population in the world. Because of the illiteracy of the masses, the enumerators are not in a position to get reliable information. I am not suggesting that illiterate persons are necessarily wanting in intelligence. What I wish to say is that our illiterate masses while quite intelligent in economic matters, are not so smart in remembering dates of birth, death, marriage etc. Because of this, among other causes, ages are misreported. The reasons which underlie age misreporting in India are quite different from those in Western Countries and it is very desirable that the Census Commissioner undertakes some researches to find out the types of errors introduced in age reporting.

3. In India general instructions to the enumerators are written in English and they are translated in regional languages by the census superintendents. There are many words in English which cannot always be translated in a regional language, and at times it is not possible to find words connoting same meaning in all the regional languages. It is very desirable that the Census Commissioner appoints an expert committee for the purpose so that we can be sure that there are no regional variations in the general instructions.

5. SRI J. K. PANDE (Lucknow).

Sri J. K. Pande drew pointed attention to the fact that the population census differ fundamentally from sample survey studies in that the questionnaire and schedule for the population census had to be necessarily very brief and could not accommodate questions which were conceptually complex.

2. He also emphasised the need of care being taken to ensure that comparability of the data collected in the 1961 Census was maintained in relation to allied data collected in the previous Census. Every 10 years there was a new Census Commissioner, who was not in particular love with the definitions, concepts and ideas of his predecessors and who had his own new and bright ideas which had quite rightly, to be utilised. Apart from this, new and bright research workers came into the field, who were not available at the time of the previous Census, and they also contributed to new ideas and concepts. While the Census had to keep pace with dynamic society, perhaps it could be possible to ensure that where a departure from previous concepts and definitions was considered necessary or desirable, the departure was not complete and abrupt or data according to the old concepts and definitions were collected, at least once, simultaneously with new concepts and definitions, so that the new series of data could possibly be connected with the old series.

3. Sri Pande did not agree with the suggestion made by Dr. V. K. R. V. Rao that workers may be divided into (1) full-time workers, (2) earning dependants,

and (3) dependants. In his opinion, the first two classes may overlap, as a person may be both a full-time worker and an earning dependent. Nor did he consider Dr. Rao's suggestion feasible that the census should extend to a period of one year in order to make collection of data on socio-economic matters possible on an annual base. (Dr. Rao later clarified the statement by stating that he only meant that a sample survey should be conducted for a period of one year in close relation to the census). Sri Pande considered collection of socio-economic data for a full period of one year to provide bench-mark measurement necessary and useful, but thought that such data could not be collected during or in connection with the census; they had to be obtained by means of supplementary sample surveys.

4. Sri Pande referred to the opening remarks of the Census Commissioner to the effect that appointment of local persons as census enumerators had advantages but possibly also some disadvantages arise from the fact that their local knowledge might possibly condition or affect the respondent's replies as reported by the enumerator. Sri Pande considered this an important aspect possibly affecting the reliability of primary data and suggested that it may be useful to test, by a pilot survey, whether and how far reliability of primary data was affected by the fact that the enumerator was a local man. If the pilot survey indicated that the differences were insignificant, it would provide an assurance based on scientific basis. On the other hand, if the pilot survey brought out that the differences were significant, it might provide ground for further detailed inquiries as to which agency gave more reliable results and the degree of divergence between the data reported by local and outside enumerators.

Dr. V. K. R. V. Rao, New Delhi and Dr. P. V. Sukhatme, New Delhi also participated in the symposium.

1. SOLID STATE AND CRYSTAL STRUCTURES

Section of Physics

Chairman : PROF. A. K. DUTTA, Cuttack.

1. R. RAMANNA (Trombay) : *Neutron Thermalisation and Solid Structure.*

A study of the thermalisation of neutrons in solid moderators gives some information as to the nature of the chemical binding in the solids. During this process, the neutrons lose and sometimes gain energy as a result of interaction with the crystal lattice and the mean energy of the neutrons decreases almost exponentially to an equilibrium value. The time constant of this process can be measured experimentally either directly by measuring the mean energy as a function of time or by measuring the 'Diffusion Cooling Constant' for a finite assembly of the moderators. Theoretical estimates of this 'Thermalisation time' have been made assuming various models for the lattice structure of the solids. The agreement between theory and experiment is not very good.

2. L. S. KOTHARI and K. S. SINGWI (Trombay) : *Neutron Scattering and Lattice Dynamics.*

With the availability of high intensity neutron beams from reactors, the interest in the study of neutron-lattice interaction has constantly been growing. By measuring the energy distribution of neutrons inelastically scattered from a crystal it has become possible, for the first time, to get direct information about the dispersion relation of elastic waves in a solid and in certain cases, about the frequency distribu-

tion function. Much theoretical and experimental work has been done abroad on aluminium, germanium and liquid helium II. Authors have also studied theoretically the scattering surfaces in graphite, which has a highly anisotropic lattice. It is proposed to briefly review all this work.

3. P. K. IYENGAR (Bombay) : *Normal Vibrations of Germanium by Neutron Spectrometry.*

The energy distributions of neutrons scattered from a single crystal yield the frequency-wave number relations of the normal modes of the crystal. The neutron groups observed satisfy the relation $k - k' = 2\pi\tau - q$; $E - E' = h\nu$, where k and k' are the ingoing and outgoing neutron propagation vectors, E and E' are the ingoing and outgoing neutron energies, τ is a reciprocal lattice vector and ν and q are respectively, the frequency and propagation vector of the normal mode with which the neutron interacted. These equations enable ν and q for the phonons to be determined from the measured energy distributions. The dispersion curves of the normal modes of germanium in the symmetric [100] and [111] directions [both acoustic and optical branches] have been obtained from scattered neutron energy distributions. The results cannot be fitted by the Born-Von Karman theory with general first and second neighbours forces. The specific heat variation at low temperatures could be explained on the basis of observed phonon spectrum. The far infra-red absorption spectra can be almost completely interpreted as summation bands in terms of our results.

4 V. P. DUGGAL and K. SRI RAM : *Single Crystal Neutron Spectrometer at Apsara Reactor.*

The construction of a single neutron crystal spectrometer at Apsara reactor shall be described. In order to determine the contamination due to higher order reflections from the crystal, a study of cold neutron filters and a mechanical velocity selector has been undertaken. Preliminary results on the spectrum of neutrons emerging from a beam hole will be presented.

5. DR. V. V. THOSAR (Bombay 1) : *Luminescence Decay in Crystals Excited by High Energy Radiation.*

The nature of emission spectrum of luminescent crystals whether excited by ultra-violet, cathode rays or gamma-rays, is known to remain unaltered. However, in the case of excitation by electrons or gamma-rays, prior to excitation of luminescence centres, there are initial processes of production of secondary electrons and of transport of energy from excited secondary electrons to luminescence centres and other centres in the crystal, accompanied by stronger lattice vibrations. It is, therefore, of some interest to investigate whether luminescence decay rate, particularly in the initial stages, is influenced by the energy of the exciting radiation. Previous work indicates that power law decays in some zinc sulphide type of phosphors are quite sensitive to changes in temperature, excitation density and kind of excitant—the decay rate increases with cathode ray excitation than with ultra-violet and it increases also with electron current density. Kröger also found an increase in decay rate with temperature for some inorganic phosphors.

We have investigated the luminescence decay rate in single crystals of NaI(Tl) and CsI (Tl) with the usual scintillation equipment used in nuclear research, in conjunction with a Tektronix high speed oscilloscope. Single pulses were photographed under excitation with 1.28 MeV γ -rays and also due to cosmic ray background. A large number of decay curves in each group were analysed by the method of least squares to determine decay time. In the background pulses from

CsI (Tl), the results indicate a faster decay rate in the initial stages (average decay time 1.5 micro-sec.). Also for NaI (Tl) the decay rate is faster in the background pulses than for 1.28 MeV. γ -ray excitation (average decay time 0.3 micro-sec.).

An explanation for change in decay rate with the nature and energy of excitant can be given on the basis of a competing radiationless transition, the probability of this process increasing with stronger lattice vibrations, caused by the passage of high energy radiation.

6. M. L. BHAUMIK and H. N. BOSE (Kharagpur) : *Fine Structure of Energy Transfer in Some Organic Phosphors.*

Transfer of excitation energy and fine structure in energy transfer have been found to occur in the following systems—diphenyl-anthracene, diphenyl-dibenzanthracene and stilbene-naphthacene. A spectrographic investigation of energy transfer and its fine structure has been carried out with these new systems. From a comparison of the fluorescence spectra of the samples with the absorption spectra of the impurities it is established that the fine structure of energy transfer is due to the reabsorption of the matrix fluorescence by the impurity molecules. The trapping of fluorescence radiation inside the crystal is found to enhance the effect of absorption. Thus, although the general diminution of the matrix fluorescence intensity with increasing impurity concentrations is believed to be due to the resonance process, the fine structure of energy transfer is seen to be due to the re-absorption of fluorescence radiation. The study also indicates that the role of photon process in energy transfer, at least in the systems investigated, is quite considerable; the contribution of such a process in energy transfer has been generally underestimated.

7. D. D. PANT (Nainital) : *U-Activated Phosphors.*

A brief account of uranyl like fluorescence is given. A comparison of the spectra-pure solids, solutions and activated solids and glasses is made. A discussion regarding the emitters in solid, solution and activated phosphors shows that while in the former case only one emitter (UO_2) is held responsible for the entire spectrum, in the latter two there is definite evidence, for other types of emitters. The luminescence of Uranyl and uranate type of phosphors is described. Several interesting phenomena observed in the U-activated phosphors and their bearing on the atomic configuration of the luminescent centres, physical properties of the matrix, charge compensation theory, electronic traps and energy transfer process is discussed. The work carried out on the U-activated boric acid glass, in author's laboratories is finally reviewed in the light of the above. Particular attention is drawn to the phenomenon of anti-stokes fluorescence and its bearing on the internal degradation of excess vibrational energy of the excited molecules.

8. A. CHOUDHURY, K. V. RAO and J. SHARMA (Kharagpur) : *Paramagnetism and Dielectric Polarisability of Colour Centres in Alkali Halides.*

The colour centres produced in a few alkali halides have been studied with respect to their magnetic and dielectric properties. It is found that the centres containing unpaired electrons show a weak paramagnetism which obeys Curie Law. The centres also increase the dielectric constant of the samples, showing that the trapped electrons are more polarizable than the valence electrons. After thermal or optical bleaching the crystals show an increase in the dielectric loss. This is probably conduction loss produced by the cationic vacancies which are set free in the lattice by the combined effects of coloration and bleaching.

9 C. RAMASASTRY and S. K. GHOSH (Kharagpur) : *Studies on Surface States of Tellurium Films.*

The electrical conductance of thin films of Tellurium (about 500 Å° thick), deposited on glass, slides by evaporation in vacuum, was studied as a function of different gas ambients. The tellurium films exhibited p-type or hole conductivity. The observed conductance changes can be attributed to the transfer of charge to the adsorbed gas molecules which constitute the so-called outer surface states.

The occupation and depopulation of the inner surface states (Tamm type states) which are known to have time constants of the order of microseconds was also studied by following the modulation of the conductance on application of transverse electric fields of the order of 10^4 volts per cm. and of frequencies in the range 40 to 200 cycles per second. This "Field Effect" was measured on a freshly deposited film kept in high vacuum, and it was followed as different gases were introduced into the vacuum chamber. The observed changes in "Field Effect" indicated surface scattering effects on the mobility of induced charges similar to the results reported in the case of Germanium surface.

Dry gases H_2 , N_2 , Air and O_2 progressively increased the conductance which indicates that the film becomes progressively more p-type. The effective mobility calculated from the "Field Effect" data shows that a freshly prepared film has an "exhaustion" layer on the surface in vacuum and in H_2 while N_2 , Air and O_2 produced more p-type (accumulation) layers. By combining the Hall mobility and the "Field effect" mobility data, on the same film, the calculated values for the energy of the surface states at the glass-tellurium interface is different from that of the exposed surface.

10. B. VENKATARAMAN (Bombay) : *Solid State Masers.*

The inversion spectrum of the ammonia molecule was employed by Townes and his co-workers to construct a gaseous "Maser" i.e., a "Microwave Amplifier using Stimulated Emission and Radiation". Recently, Feher, Scovil, Bloembergen and others have constructed masers using matter in the solid state. The principles underlying the operation of a solid state maser using a paramagnetic crystal will be discussed. Such quantum mechanical amplifiers have very low noise figures and hence may be very useful in radio-astronomy and other fields where signals of very low intensity have to be detected.

11. S. S. DHARMATTI (Bombay 1) : *Nuclear Magnetic Resonance and Crystal Structure.*

Recently, nuclear magnetic resonance has become a new tool for the study of crystals and serves as a supplement to probing the crystals with X-rays and neutrons. This method is particularly useful in locating light atoms such as Hydrogen and Lithium which are weak scatterers of X-rays and consequently cannot be readily located by the X-ray method. Besides, the studies of nuclear magnetic resonance line shapes and intensities and relaxation times reveal profound information regarding crystals. Experiments in adiabatic demagnetization of crystals with long relaxation times have raised extremely interesting questions such as the state of the system and idea of negative spin temperature. Some of these problems arising from the nuclear magnetic resonance study of crystals will be discussed along with the technique of this study.

12. M. D. NARASIMHAN (Hyderabad-Dn.) : *Solid State Reaction in Ceramics.*

In recent years there has been an increasing demand for materials of construction having desirable mechanical, thermal and electrical properties for various

applications such as in nuclear energy, electronics, gas turbines, jet engines, rockets, etc. Ceramic materials are being successfully used in these applications and offer a potential source of supply. However, the challenge posed to the ceramic engineer is very great on account of the stringent conditions these materials have to satisfy.

The sintering process by which these materials could be fabricated has received considerable attention and one needs a thorough understanding of the fundamental concepts in order to be able to fabricate materials having desirable mechanical, thermal and electrical properties. The micro-structure that is governed by the sintering process influence these properties considerably. Since the presence of a liquid phase has a detrimental effect on some of these properties, materials have to be sintered in the solid state. Hence a knowledge of solid state physics is necessary in understanding not only the sintering process but also the behaviour of ceramic materials in these applications.

Concepts of solid state physics as applied to the sintering process, phase transformations, ferroelectric and ferromagnetic properties, mechanical properties, and thermal properties are discussed.

13. R. P. SINGH (Bombay) : *Electron Correlations in Metals.*

The success of the Drude-Lorentz theory of free electrons in metals, in the prediction of the correct form of Wiedemann-Franz law ($\frac{K}{\sigma T} = \text{Const.}$), was a corner stone in the understanding of the behaviour of electrons in metals. The electrons were considered as a perfect gas obeying the Maxwell-Boltzmann statistics.

The Fermi-Dirac statistics was applied by Sommerfeld who gave a better form of the Wiedemann-Franz law and also the correct specific heat of the free electron gas. Pauli worked out a theory of the paramagnetism of free electrons based on the use of F.D. statistics. Besides these, several other features like thermionic emission and contact potentials of metals were also explained.

This model of a metal in which electrons are free and move inside a metal in a potential box of constant depth is very crude and it succeeds in all phenomena in which the depth of the potential well is not important. Also one likes to understand this model in terms of the electronic structure of metals in which electrons move in the periodic potential field of the positive ions. Quantum mechanical treatment of the motion of electrons in a periodic lattice and the resulting band theory of solids provided such an understanding.

It was natural, however, to extend the above free electron picture to more realistic situation in which the electrons are interacting on account of the Coulomb repulsion. This was done by Hartree who considered each electron moving in the resultant potential due to positive ions and the other electrons. The contribution by the electrons will decrease the depth of the potential well to a small value. The Hartree theory will be successful where the Sommerfeld theory was and where the depth of potential well is unimportant.

The depth of the potential well will, however, be important if one wants to calculate the cohesive energy of a metal. The Hartree theory completely fails in achieving this. An improvement is possible; if one uses the Hartree-Fock scheme but in doing this one destroys the success of the theory in predicting the correct specific heat and paramagnetism of electrons as well as the X-ray band widths. This is so because the Hartree-Fock theory gives zero density of states near the top of the Fermi surface.

A description of electrons in metals can be given on the plasma theory as done by Bohm and Pines in their monumental work. It is intended to give in this talk an outline of the Bohm-Pines method and its successes in various situations confronted with the many electron problem.

14. A. GOSWAMI (Poona 8) : *Structure Analysis by Electron Diffraction.*

Though electron diffraction has been widely used for the studies of thin films, crystal growth process, phase transition in crystal, etc., and also to determine cell dimension, symmetry, habit and orientations, lattice perfection of crystals, no detailed crystal structure analysis was, however, possible till recently due to the lack of precise understanding of the scattering of electrons by the potential field of a crystal. The main defect of the theory and also in its experimental confirmation may be ascribed to (i) the absence of any reliable method for the evaluation of electron scattering factor ($g(\theta)$) for atoms or ions (ii) complications in the intensity (I) of reflection arising from the dynamical interaction of electrons with the crystals, when I becomes proportional to E but not to E^2 (analogous to I^2 of X-rays) (iii) difficulty in the correct estimation of E , (iv) forbidden reflections caused by double scattering of the electron beam.

These defects have now been considerably removed by the researches of Soviet and Australian workers, who have successfully solved many crystal-structure problems from the intensity of arcs or spot patterns of one-degree orientated crystals or thin single crystals by applying Fourier methods and shape transform functions. The correlation of spot intensity with structure factor (E) has also been possible by a novel technique of spreading the spots to rectangles with electrostatic deflectors. The critical crystal-thickness for the application of kinematical or dynamical theory has also been derived in many cases. Complete structure analyses of various compounds e.g., BaCl_2 , $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$, $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$, carbide, nitride, selenides and telluride of bismuth, silicates, boric acid and also of organic compounds such as paraffin wax, diketopiperazine etc. have been carried out. The positions of hydrogen atoms, especially in organic compounds and also in boric acid, have very clearly been demonstrated from the Fourier projection. The peculiar position of hydrogen in boric acid arising as a result of disorder in layers has also been shown.

The groups of spots, formed around a primary reflection having no correspondence in X-ray, have also been shown to be due to crystal habits and these fine structures have also provided an independent method for evaluating ' E ' as well as the inner potential of the crystals.

15. PROFESSOR R. S. KRISHNAN (Bangalore) : *Analogue Computers for X-Ray Crystal Structure Analysis.*

Computations involving double Fourier series are finding increasing applications in many problems and the determination of crystal structures by means of X-ray diffraction is one of them. The difficulties associated with such calculations are well known and the need for computers to aid the X-ray worker has long been felt. The first part of the paper deals with a critical analysis of the needs of X-ray workers and how and to what extent they have been met in various forms of computers. The latter part of the paper deals with an analogue computer for X-ray crystal structure analysis designed by Dr. G. Suryan and constructed at the Physics Department, Indian Institute of Science. The computer is based on the synchronous recording of sinusoidal waves on a magnetic drum and magnetic addition. Details of design and construction are given. The computer gives the result directly in the form of contour maps of electron density and illustrative contour maps are presented. The inverse problem of calculating X-ray intensities from crystal structures is also briefly touched upon.

16. DR. K. S. CHANDRASEKHARAN (Madras) : *Anomalous Dispersion and Absolute Configuration.*

In usual crystal structure analyses it is not possible to distinguish between two structures which are mirror images. This happens because of a fundamental

law of x-ray diffraction known as Friedel's law, as a result of which inverse reflections are of equal intensity. However, if the absorption edge of one of the atoms in the structure is very near the wavelength of the incident x-ray beam, Friedel's law will be violated due to anomalous dispersion and the inequality of inverse reflections could be utilised for finding the absolute configuration.

The effect is appreciable even if the absorption edge lies far away from the exciting X-ray wavelength and by accurate intensity measurements with a Geiger spectrometer the absolute configuration could be established. This has been done for structures like sodium chlorate, glucosamine hydrochloride which contain chlorine (K edge of Cl 4.40 Å) using Cu K- α radiation (1.54 Å). Further, it has been found possible to determine both the structure and the configuration making use of the anomalous dispersion effect, since the experimental measurements of the intensity difference of inverse reflections give valuable information regarding the phase of the structure factors. Ephedrine hydrochloride and lysine hydrochloride have been studied utilising this principle.

17. R. K. SEN (Calcutta) : *Use of the Characteristics of the Thermal Vibrations in Crystal Structure Analysis.*

The crystal structure of a substance cannot be uniquely determined by the Fourier series method since the phase of the structure factors cannot be obtained from experimental measurements. For the applications of Fourier series method a preliminary structure is first obtained from various other physical and chemical criteria. The shapes of thermal diffuse spots is one such criteria which may be utilised in a qualitative manner in determining the molecular planes in layer structure as well as chain directions in chain structures.

The thermal vibrations of atoms give rise to diffuse spots in over exposed Laue photographs when Bragg reflection condition is nearly but not exactly satisfied. The displacement of one atom will influence their neighbours and consequently the intensity distribution in the diffuse spots will in general be dependant on the structure of the crystals. It is not however possible to determine the complete structure from measurements of intensities of the diffuse reflexions. Nonetheless it is possible to derive some characteristics of the structure from the shape of the diffuse spots.

The intensity of the diffuse reflexion is approximately proportional to the square of the component of the amplitude of vibration normal to the plane giving rise to the reflexion when the Bragg reflexion condition is nearly satisfied. In layer structures the vibrations of the atoms perpendicular to the layer planes will be much more pronounced than the vibration parallel to the planes. Consequently planes approximately parallel to the layer plane shows large elliptical diffuse spots.

In chain structures, Muller has shown that the compressibility is several times smaller along the chain direction than at right angles to it. Consequently the longitudinal waves along the chain directions will have very small amplitudes. Transverse waves along the directions perpendicular to the chain direction can have appreciable amplitudes, since these waves involve relative displacements of the chains along the chain direction and do not involve the straining of a particular chain. From this consideration, it can be shown that the planes approximately perpendicular to the chain direction give rise to narrow streak-like spot whereas planes parallel to the chains give elliptical spots. A few examples of such observations in known structures are given.

18. PROF. K. BANERJEE (Allahabad) : *The Phase Problem in Crystal Structure Analysis.*

According to the lattice theory the electron density distribution inside a crystal must have a three dimensional periodic structure. As any periodic distribution can

be represented by a fourier summation we should be able to represent in such a way the electron density $\rho(xyz)$ at a point where x, y, z represent the co-ordinates of the point as ratios of the periodicities a, b, c . It can thus be shown that

$$\rho(xyz) = \frac{1}{v} \sum_{\infty} \sum_{\infty} \sum_{\infty} F(hkl) \exp.(-2\pi(hx+ky+lz))$$

The condition that ρ must be a real quantity leads to the result that pairs of terms corresponding to $h \ k \ l$ and $\bar{h} \ \bar{k} \ \bar{l}$ should sum up to

$$2|F(hkl)|\cos(\delta \cdot \phi) \text{ where} \\ \phi = 2\pi(hx+ky+lz)$$

and δ is obtained from relation

$$F(hkl) = |F(HKL)|e^{i\delta}$$

If we are able to carry out the above Fourier summation we may obtain the electron density distribution inside the crystal from which we should be able to locate the atoms in unit cells. But though $|F(hkl)|$ is known from the integrated intensities of reflections, the carrying out of summation can not be reduced to routine calculation due to difficulty of knowing δ . Hence the determination of phase term has become the pivotal problem in crystal structure analysis.

The most extensively used method so far has been that of trial and error. The method consists of postulating some structure arrived at from considerations of the known chemical bonds in the substance and other physical properties and calculating the structure factors as well as the phase terms. Among the physical properties the magnetic anisotropies are found to be the most useful for this purpose though other properties such as optical anisotropy cleavage etc. are also found to be useful. The choice of phase terms become much simpler if the crystal possesses a centre of symmetry or if in the case of two dimensional synthesis, a projection having a centre of symmetry is chosen. In such a case the phase is either 0 or π or in other words the structure factors may have only a positive or negative sign. The calculated structure factors are compared with the experimental ones and when a reasonable agreement is obtained the corresponding theoretical phases are used in carrying out the fourier synthesis. The correct synthesis is indicated by absence of negative electron densities and the atoms known to be present in the unit all coming out in the projection. A more quantitative criterion of correctness of the structure is obtained by the help of the Booth's R-test in which the quantity

$$R = \frac{\sum (F_o - F_c)^2}{\sum F_o^2}$$

(where F_o = observed and F_c = calculated structure factors) comes out to be as low as possible. Though theoretically sounder tests have been found still this expression is most commonly used on account its simplicity.

In the trial synthesis the criteria that guide us are the existence of the known atoms in the structure and absence of negative electron densities. So if one could utilise these facts in order to obtain the phases directly by some mathematical process the problem would be solved. The first of these criteria was used by the author for the special case of a centrosymmetric crystal with identical atoms in 1933 by setting up a set of simple algebraic equations relating the structure factors only. The signs of these structure factors whose numerical values are known may be obtained by easy trials so as to make the equations hold true. Geodkoop (1952), in a remarkable contribution, has generalised the method by removing the restriction that the atoms in the crystal have to be identical.

The other criterion namely that of non-negative electron density has been utilised by Harker in deriving a set of inequality relations between structure factors by the help of which signs of some of the structure factors are uniquely determined.

Both these methods have their limitations. In the first method, the number of independent atoms become large, the necessary number of actually measured structure factors may become too large. The number of structure factors that may be measured is limited by the sphere of reflection and hence can not be increased indefinitely. While with the help of the second method only a few signs may be determined. It has not yet been possible to set up equations in which both these criteria may be utilised simultaneously. Another knowledge that we utilise in the trial methods is that of the known interatomic distances in the molecule of the substance. Some statistical relationships among structure factors have been derived by Karle and Hauptmann which may be utilised to determine the phase unambiguously. This method is still in a stage of development and its success can only be judged in course of time.

Though the Fourier synthesis of electron density is difficult on account of the phase terms Patterson showed that if a Fourier synthesis of $|F(hkl)|^2$ terms instead of $F(hkl)$ terms be carried out and plotted. The lines joining the peaks of this plot to the origin represents interatomic vectors. This can be carried out in a straight forward way as no phase term is involved. But the main difficulties in such a case are that (1) the peaks are not usually sufficiently pronounced as to indicate a clear maximum and (2) the number of interatomic vectors is $n(n-1)$ where n is the number of atoms and so when n is fairly large (where any such method is useful) it becomes too large, for the peaks to be deciphered.

The peaks can, as shown by Harker, be sharpened by dividing the structure factors by the corresponding atomic scattering factors in case, the atoms are of one kind or by the electronic scattering factor which may be assumed to be the same for all atoms. But in cases where the atomic number differ widely this method leads to faulty informations.

On the other hand the Patterson synthesis is most useful where the unit cell contains a very few atoms of heavy elements so that the results may be deciphered easily. In fact this advantage of heavy elements has led to a very useful method in structure analysis, namely, the isomorphous replacement method. The method of isomorphous replacement sometimes gives direct information about the phases since the increase or decrease of any structure factor due replacement of any atom by a heavier one usually indicates that the sign of the structure factor is respectively the same as or opposite to that of the contribution of this particular atom.

The above discussions show that the method of trial and error still remains the sheet anchor for structure analysis. Physical properties of crystals particularly the magnetic properties as developed by the Indian school have been found to be very powerful aids to this method. Due to recent developments of the electronic computing and other devices as well as optical analogues the attempts now centre round making quicker and quicker trials by their aids. The most powerful of all such methods is that of Pepinsky in which a Fourier projection appears on the screen of a cathode ray oscillograph in an extremely short time.

II. I. G. Y. DATA

Chairman : PROF. A. K. DUTTA, Cuttack.

1. M. K. VAINU BAPPU (Naini Tal) : *Photography of the moon and optical tracking of artificial satellites.*

Two main programmes carried out at the Uttar Pradesh State Observatory, Naini Tal under the auspices of the International Geophysical Year are, photography of the moon with the aid of the Markowitz moon camera and the precision optical

tracking of artificial satellites. The latter project is carried out in co-operation with the Smithsonian Astrophysical Observatory at Cambridge, Mass., U.S.A.

The Markowitz moon camera is used in conjunction with the 10-inch Cooke refractor of the Observatory. The moon's image is cut down a 1000 fold in intensity by a neutral density filter placed before the photographic plate. This filter is tilted about an axis perpendicular to the optic axis at a known rate, in order to compensate the moon's motion during the interval of exposure. At the instant of parallelism between the neutral filter and photographic plate, an electric impulse actuates a chronograph pen to record the epoch of the exposure. Time signals are fed into the chronograph from a quartz clock reading Universal Time. Plates taken with the moon camera enable the measurement of the position of the moon against the back ground stars with a precision hitherto unattainable. Such measures help the obtaining of Ephemeris Time and have many interesting geodetic applications.

The optical tracking of artificial satellites is carried out with the aid of a 20-inch aperture f/1 Schmidt camera specially designed for the purpose. The mounting has three axes which permit the camera to track in any direction across the sky. The field of view is 30 degrees by 5 degrees. The camera can track alternately at sidereal rate and at the rate prescribed by the angular velocity of the satellite. The epoch of the exposure on any one frame is obtained by photographic registration on the emulsion of the face of a slave clock within the camera. This slave is controlled by a quartz clock which enables the time presentation readable to 1/10,000 second.

The high accuracy orbits of the satellites and changes in their orbital characteristics can be determined with high precision from the measures of position thus obtained. The use of such data in determinations of upper air densities, distribution of mass inside the earth, and other geodetic problems is discussed.

A. P. MITRA (Ahmedabad) : *IGY observations at the Radio Propagation Unit.*

IGY observations at the Radio Propagation Unit include : (1) Vertical incidence soundings by a 10 KW automatic recorder—C-4 type—sweeping from 1 to 25 Mc/s, (2) Observations of galactic radio noise at New Delhi and Mussourie at 22 and 30 Kc/s, (3) Measurements of the intensity of atmospherics at 27 and 100 Kc/s. There is, in addition, the work of coordination of ionospheric data, and of prediction of sunspot numbers and of foF2 and (M3000) F2. A 24-hour solar patrol has been kept using all the three radio methods mentioned above.

Results of these observations to date are reported and discussed. There are some unusual observations of ionospheric effects of solar flares. The C-4 recorder has on several occasions been put on 2 minute schedules; results obtained with these schedules are also discussed.

R. P. KANE (Ahmedabad) : *Cosmic Ray programme for the I. G. Y.*

The Cosmic Ray Committee for the Current International Geophysical Year recommended a set of experiments as a part of the general programme of the International Geophysical Year.

The experimental devices adopted are as follows :—

- (i) Ionisation Chambers—I
- (ii) Geiger Counter telescopes—T, T*.
- (iii) Counter assembly for shower detection : here, Geiger counters and/or Scintillation detectors are used.—S.
- (iv) Neutron monitors, detectors—NM or N
- (v) Cerenkov Counters—C
- (vi) Proportional Counters—P

- (vii) Emulsion technique—E
- (viii) Experiments with balloons—(+)
- (ix) Underground experiments—U

(i) Ionisation Chamber measurements would give us omnidirectional Cosmic Ray intensity through the amount of ionisation produced by them. The chambers are usually shielded with about 10 to 15 cm. of lead or iron, to eliminate natural radioactivity and soft component cosmic rays.

(ii) Geiger counter telescopes are assembly of Geiger counters in an electronic coincidence arrangement. The opening of a telescope i.e. the angles with the vertical in the E-W and N-S planes within which particles can be recorded are determined by the dimensions of the end trays and their separation. Arrangements with fairly wide openings, specially the Cubical Meson telescope geometry where each tray is a square and the separation between the end trays equals the side of this square, are termed as T. For narrower angles, the symbol T* is used.

(iii) Geiger counter trays placed in the same horizontal plane and arranged in coincidence have been arranged for shower detection. Scintillation detectors are utilised.

(iv) A neutron monitor is an assembly of lead bricks and paraffin blocks in which a few $B^{10}F_3$ neutron counters are placed. The purpose is to detect the nucleonic component of cosmic rays. The paraffin and lead are used to slow down the nucleonic component and multiply the same by local production of stars.

(v) Cerenkov counters are used for detecting very high energy Cosmic Ray particles through their photon emission capacity. The photons emitted are collected on a photo-multiplier tube after reflections.

(vi) Emulsion technique recording the ionisation tracks of Cosmic Ray in a photographic emulsion have been used.

(vii) Proportional counters are used for detecting and distinguishing between various types of Cosmic Ray Particles.

(viii) Balloon ascents are usually carried out for intensity vs. altitude measurements of Cosmic Ray as also for studying nuclear reactions of Cosmic Rays at high altitudes where Cosmic Ray intensity is much more than at sea level. The ascents also give information about meteorological conditions in upper atmosphere.

(ix) Cosmic Ray measurements carried underground studies the penetrating component of Cosmic Rays.

The emphasis has been, however, on the measurements with Ionisation Chambers, Counter Telescopes and Neutron Monitors. In India, the laboratories contributing to this programme are as given in the Table. They are reported to the World Centres for comparative study.

TABLE I

Station	Altitude (Meters)	GEOGRAPHIC		Operating Recorder
		Latitude	Longitude	
Ahmedabad ...	SL	23°01	E 72°36	TNMT*
Howrah ...	SL	22°33	E 88°19	I
Gulmarg ...	2743	34°03	E 74°24	TNM
Darjeeling ...	2176	27°03	E 88°16	T
Kodaikanal ...	2443	10°14	E 77°28	TNMT*

4. S. L. MALUKAR : *Exceptionally large solar and geophysical events.*

The chromospheric eruptions (solar flares) of solar active regions affect almost contemporaneously (taking account of the velocity of light) on the day-light side of the earth's hemisphere within an area of about 70° of the sub-solar point (McNish cone) and give rise to temporary short time changes in the geomagnetic field (chrochet) and to ionospheric disturbances in D and E layers leading to a radio fade-out. After 24 to 48 hours, often a world-wide geomagnetic storm may follow. The incoming cosmic rays, the solar noise and details of spectroscopic phenomena may also contemporaneously change. The cosmic rays may decrease and closely follow the changes in the one to two days later world-wide geomagnetic storm.

2. Among the large number of solar events which happen, the sorting out requires considerable preparation. The exceptionally large events assume great importance as they naturally classify themselves out.

3. In the last twenty years, five very large events with contemporary cosmic ray bursts occurred :—

Feb. 28, 1942

Mar. 7, 1942

Jul. 25, 1946

Nov. 19, 1949

Feb. 23, 1956

While a day or so after the eruptions of Feb. 28, 1942 and July 25, 1946 world-wide geomagnetic storms with simultaneous cosmic ray changes were recorded, no such combined or inter-related subsequent geomagnetic and cosmic ray disturbances were recorded in the other three instances. To these five, two more events when only geomagnetic disturbances (two biggest ones recorded at Alibag) with no corresponding cosmic ray changes, were added and all the seven were studied with the evolutionary history of the connected solar active regions. It was found :—

- (i) The cosmic ray bursts happened with solar active regions which were very active and had a history of great activity more than 6 days.
- (ii) When the chromospheric eruptions of such a solar active region happened near the C.M. of the sun, there was an increase of cosmic ray intensity (a burst) and after about a day, a world-wide geomagnetic storm with corresponding cosmic ray changes followed. (Feb. 28, 1942; Jul. 25, 1946).
- (iii) When the Chromospheric eruption of the same type of very active region took place near the western limb of the sun there was a great burst of cosmic rays with short time geomagnetic changes (crochets) in the McNish cone. No inter-related geomagnetic cosmic ray disturbance followed in the next 24 to 48 hours (Mar. 7, 1942; Nov. 19, 1949; Feb. 23, 1956).
- (iv) No such event has yet been recorded at the eastern limb of the sun with very active regions.
- (v) On Nov. 19, 1949 and Feb. 23, 1956, the solar flares caused an increase in electron density in the F2 which according to Minnis and Bazzard is rare unlike the usual solar flare effects which give "a simultaneous increase in the electron density in the D and E layers". The geomagnetic crochet at Alibag on Mar. 7, 1942 is very marked and similar to those recorded by Kodaikanal on Feb. 23, 1956 that it is likely that F2 layer was also affected on Mar. 7, 1942.
- (vi) The purely geomagnetic storms were related to very active solar regions with more ephemeral history soon after their C.M. passage (Mar. 1, 1941 and Mar. 28, 1946).

TABLE

Year	Solar Active Region				Solar Flare			Date of		Interval between		Remarks
	No.	Coordinates ϕ L.	C. M. Passage Date	No. of Distinct Observed Flares	Date	C.M. Dist.	Age	Cosmic Ray Burst	Magnetic Storm	Magnetic Storm and Flare C.M. Passage	Cosmic ray affected Mag. stm.	
1941	7	15N	Feb. 27.5	2	—	—	—	—	Mar. 1.15	—	1.35	—
1942	12	7N	Feb. 28.8	+26?	Feb. 28.5	4E	+26?	Feb. 28.5	Mar. 1.31	0.81	0.51	—
"	—	—	—	—	Mar. 7.18	91W	+32?	Mar. 7.18	—	—	—	—
1946	15	23N	Mar. 26.9	>6	Mar. 27.2	4W	>6	—	Mar. 28.1	—	1.41	—
1945	51	21N	July 26.8	>6	July 25.67	16E	>5	July 25.67	July 26.8	1.1	0.0	—
1949/4	23	2S	Nov. 14.1	3	Nov. 19.40	75W	8	Nov. 19.44	—	1.13	—	—
1956/1	17	22N	Feb. 17.8	>6	Feb. 23.13	80W	11	Feb. 23.13	—	—	—	—

[Note :

(a) C. M. distances and age refer to those of the solar active region numbered in each row.

(b) C. M. distances approximate to within a few degrees only due to inherent observational approximations.

(c) For No. 23 (of the fourth quarter of 1949) active region, the age at C. M. Passage is given as -1 in Q. Bull. of I.A.U., Zurich. It had been observed at Mitaka on Nov. 11, at Kanzelhöhe on 13th and again at Mitaka on 14th. The age has been changed accordingly. It is also mentioned that this active region was a fresh formation on the return of active region No. 13 of 1949/4.

(d) No data of F2 region behaviour available for Feb. 28, 1942, March 7, 1942 and July 25, 1946.]

4. Most of these along with the tabulated data and immediately deducible conclusions about the nature of particles (+vely charged particles from the middle of the periodic table) have been published (*Acta Physica Hungarica*, 9, II, 1958). These show that the surface of the sun, even those belts where the solar active regions form, cannot be considered as uniform in the causation of the big events, which seem to be confined to two small longitudinal sectors.

5. The next problem that was tackled was the nature of solar active regions that give rise to big events. With the data available, it was found that on days of big events, the details are very limited or are absent. Even for the one day that has been used Jul. 25, 1946 it had to be got by interpolation. Hence an attempt was made to study eight second order type events along with that for July 25, 1946--a first order event included earlier. It showed that the events with cosmic ray enhancements were determined by characteristic or distinguishable differences along with positional value stated earlier (appearing Mar. 1959 *Acta Physica Hungarica*).

6. The geophysical control or distribution of these events can easily be obtained from records of observations. Some items of solar control have been studied above. If in addition, the conditions between the sun and the earth are reasonably assumed, the self-consistent picture would add to our theoretical knowledge.

7. The above ideas were applied to determine whether on the occurrence of one geophysical event corresponding changes could be had particularly the geomagnetic storms and cosmic ray disturbances. In *Acta Physica Hungarica* Vol. 5, 1955 detailed tables from 1936-1944 have been set out. On Feb. 11, 1958 Alibag recorded a very big geomagnetic storm, the biggest after March, 1948. The character of the storm resembled very much those when cosmic ray decreases occurred as mentioned above. While no contemporary evidence was available for a few months it has been reported that world-wide cosmic ray disturbances occurred. As such a verification of the physical facts has been obtained.

I. CLAY MINERALS

Section of Chemistry

Chairman : PROF. SANTI R. PALIT, Calcutta.

1. S. P. RAYCHAUDHURI (New Delhi) : *The Role of Clay Minerals in Soil Survey Work.*

With the development of the knowledge of the composition and constitution of soil and of weathering complex, several attempts have been made to evolve classifications based on parent material or important soil properties. The first of these is probably that of Gedroiz, who showed that soils could be grouped according to the nature and amount of exchangeable bases in them. Considerable impetus has been given to this aspect of soil classification by the study of the electrochemical properties of clay by J. N. Mukherjee and his co-workers. When the importance of the clay fraction was appreciated, one or two attempts were made to show that its bulk chemical composition reflected the climatic factor, and Reifenberg drew up a scheme of classification based on the silica-alumina ratio of the clay fraction. The advent of X-ray diffraction techniques in the study of soil clays, initiated by Hadding about 1928, showed that the significance of such ratios was open to question. The extensive work of V. M. Goldschmidt and others on crystal chemistry has shown the prevalence of isomorphous replacement in minerals thus proving that attempts to correlate clay ratios with specific minerals is quite meaningless. A simple example of three distinct soil minerals having the same silica-alumina ratio

is that of muscovite, Kaolinite and halloysite which confer different properties to soils. Illite and beidellite may both have a 3:1 silica-alumina ratio. Therefore deductions based on chemical analyses are not quite reliable. The use of X-ray diffraction, together with certain chemical methods of analyses has provided extremely useful information on the World Groups. It is now possible to give a general picture of the nature of the clay minerals in many of the soils. Thus the work at Rothamsted Experimental Station, by D.M.C. Mac Ewan shows that A horizon of Tundra soils is characterised mainly by minerals of the hydrous mica or illite type. This type is also very common in the A₂ horizon of podsolised soils but is here accompanied by kaolinite. In some podsolised soil X-ray examination revealed the existence of boehmite which is an aluminium hydroxide, in the A₂ horizon. The B horizons of podsols have been characterised by illite, kaolinite and some of the minerals of the parent material. Goethite and boehmite were identified in some cases.

In the case of chernosems and other soils of the arid and semi-arid regions minerals of montmorillonite type have been identified.

Bagchi (Ind. Soc. Soil Sci. Bull. No. 6, pp. 19-41, 1951) and Nagelschmidt, Muir and Desai (J. Agric. Sci. 1940, Vol. 30, 639) from X-ray studies and Raychaudhuri, Sulaiman and Bhuiyan (Ind. J. Agric. Sci. 1943, 13 : 264) from dehydration studies have shown that Indian black cotton soils are rich in montmorillonitic type of minerals, whilst Indian red soils are rich in kaolinitic type of minerals.

As far as the relationship of clay minerals to parent materials is concerned, a common generalisation may be made that minerals of the kaolinitic type are associated with acid igneous rocks and those of montmorillonite type with basic rocks. The montmorillonite type with increasing acidity becomes unstable and breaks down. Calcareous rocks in general seem to give the kaolinitic type. Illite or hydrous mica seems to be associated with acid rocks and vermiculite-like minerals with basic ones.

The same rock may give rise to different clay minerals according to leaching conditions. Thus, Nagelschmidt, Muir and Desai (loc. cit.) have shown that the same granitic rock may give rise to red and black soils due to differences in leaching conditions.

So far soil survey has been based on fertility status, and physical properties such as texture of surface soil, permeability, depth of soil and exchangeable bases. The classification of soils on the basis of the minerological make-up of the clay fraction, however, appears to be the predominant factor in soil groupings, which along with the study of nutrient contents and above physical properties will give a complete picture for permanent soil classifications.

2 ABANI KUMAR BHATTACHARYA (Agra) : *Importance of fundamental studies of Indian Ceramic clays and their applications.*

The mechanism of clay formation in Nature has been briefly described, and the distribution of the ceramic clays all over India has also been dealt with

The changing concepts of clay structure have been reviewed and the gradual evolution of the clay mineral concept has been systematically discussed. Contributions of Van Bemmelen, Way Stremme, Gedroiz, Mattson, Wiegner, Hadding, Rinne, Ross, Shannon, Kerr, Hofmann, Endell, Hendricks and others have been referred in connection with the studies of the different types of clay minerals. The investigations of J. N. Mukerjee, R. P. Mitra, B. Chatterjee and their associates on the behaviour of Indian clays as studied by electro-chemical titrations have been mentioned; and their useful observations have been considered as giving a clue to clay mineralogy.

Contributions of Bansal, Miss Zutshi and Bhattacharya to the study of some ceramic clays of India have revealed many interesting facts regarding the variations

in pH, conductivity and total cation exchange capacity of Rajmahal, Simultala, Kasimbazar, Chitrakoot and Katni clays during their hydration. The effect of the humification of organic matter in Kasimbazar, Rajmahal and Simultala clays as also in Agra Soil has been discussed in the light of their results.

The synthetic approach to the study of clay mineralogy has been discussed with a back ground of the observations made by Noll, Gruner and others. A brief account of the work of Miss Zutshi and Bhattacharya has been given to show that the synthetic products are not identical with the natural ones, and the law of stoichiometry breaks down, when colloidal solutions are mixed together to get the desired compound. Amal Kumar's observations showed that the soluble mineral salts in the clays may be related to their swelling and shrinkage. Nagar and Bhattacharya's contributions on the variations of pH, and total cation exchange capacity of the soil show that the clay mineral properties may be affected by the decomposition of organic matter.

The industrial prospects of Indian Ceramic Clays have been discussed. Ceramic Clays have been suggested as a raw material for various chemicals, manufacture of titanium and organic high polymers.

3. K. C. MITAL and ABANI K. BHATTACHARYA (Agra) : *Electrochemical Studies of Ceramic Clays.*

One of the ceramic clays known as Rajmahal clay was rendered into the hydrogen clay by leaching with HNO_3 and washing it free from excess of the acid. The H-clay was sieved through 120-mesh, and the clay suspension (1:5) was shaken in a mechanical shaker for different intervals of time. It was observed that the pH of the clay suspension took 8 hours to reach a constant pH value.

The suspension was then titrated against N/100 NaOH solution, both by conductometry and Potentiometry. The points of equivalence obtained by both of these techniques were strikingly identical. There were three loops (two prominent and one suppressed) and three points of intersection in the potentiometric and conductometric curves respectively. These results have been discussed in the aspect of clay mineralogy.

4. D. LAHIRI and GURUDAS MANDAL (Calcutta) : *Plasticity and its relation to clay minerals.*

Although plasticity has been correlated with mineralogical make up of clay as yet there is no accepted method of measurement of plasticity. Factors determining this as well as other properties are presumably (a) ultimate particle size and its distribution (b) particle shape (c) impurities—organic and inorganic and (d) mineralogical composition. It is generally considered that halloysite, montmorillonite and illite are more plastic than kaolinite. This conclusion is based on studies made without any reference to particle size and its distribution of clay. With the object of studying the effect of these factors along with mineralogical composition on plasticity an investigation was undertaken with five Indian ceramic clays, three of which were of kaolin type, one bentonite and one consisting of a mixture of kaolinite and possibly bentonite and two English clays of kaolin type. Mixtures of clays were also prepared. One sample of a kaolin type of clay was also fractionated into four different sized fractions. Particle size distribution of these clays was determined upto about 0.06μ . The clays were purified and converted into H-clay. Plasticity was measured by various methods and it was found that Atterberg's plasticity number agrees fairly closely with the qualitative opinion of clay worker regarding plasticity. This number was found to depend mainly on the standard

surface factor calculated from particle size distribution data and an equation. Connecting these two properties could be developed. ($P = aS^m$, where P is plasticity number, S is specific surface, a and m are constants). Bentonite gave a slightly higher value than that given by the above equation. Workability of clay (index of plasticity obtained by another method) was also found to be related to standard surface factor in the same way although deviations in this case were more than in the previous case. Inherent errors in the method of measurement as well as factors other than specific surface possibly influenced these results. Bentonite gave a comparatively lower workability value.

5. A. V. RAJESWARA RAO and ABDE ALI (Hyderabad) : *Mineral Analysis of some Andhra Pradesh Clays.*

The minerals present in Kamthana, Shekapur, Pachgaon, Srirangapur and Chintriyal clays had been estimated by D.T.A., petrographic examination and staining tests. The raw as well as the various fractions of the clays obtained by sieving, elutriation, sedimentation and centrifugation and the clay-organic complexes were studied by D.T.A.

The Kamthana and Shekapur clays were mainly well crystallised kaolinites. Pachegaon clay was a poorly crystallised kaolinitic clay with a large amount of free quartz present. Srirangapur clay contained principally Ca-montmorillonite along with a small amount of kaolinite, and sieving through 200 mesh eliminated the gritty matter (50% of the clay) present in the clay leaving the finer portion consisting mainly of clay minerals. The Chintriyal clay being a mixture of quartz and mica in fine state of sub-division, was distinct from other clays by the absence of clay minerals. The impurities present in the Shekapur clay could be easily separated by mere fractionation by sedimentation method, greatly improving its quality.

6. A. N. PURI and H. J. RAJANI (Bombay) : *Importance of Specific Surface in Clay Minerals.*

Base exchange, mechanical analysis and moisture absorption have so far been presented as a series of unrelated subjects. It can be shown that they have a common denominator in the specific surface i.e. the area of the total exposed surface.

Recently much attention has been directed to the crystalline structure of clay minerals as revealed by X-ray analysis and classification of secondary clay minerals based on such analysis is becoming more and more in vogue.

When the specific surface of clay minerals is determined and plotted against their base exchange capacity all clays fall approximately on one curve showing thereby that it is the extent of the surface and not the internal structure which is the determining factor in designation of the various types of secondary clay minerals. In the phenomena of base exchange and hygroscopicity, the internal structure and composition plays no part and it is only the specific surface on the basis of which clays can be classified.

The failure to recognise the importance of specific surface so far has been due to the fact that the definition of clay included particles of 0.001 mm. diameter which fell hopelessly short of the actual size of particles. For instance, it can be shown that if the clay contained no particles smaller than 0.001 mm. the value of its specific surface will be about 3 to 5% of the total surface if the complete analysis based on particles smaller than 0.001 mm. actually present, is taken into

consideration. The following are some typical examples of Kaolinite Bentonite, and other clays with their content of 0.001 mm. particles and their specific surface.

Sample No.	Type of Clay mineral.	Particles— (0.001 mm.) %	Specific surface sq.m./g.	Base exchange capacity m.e./100g.	Base exchange capacity per unit specific surface.
3	Kaolinite ..	33.20	10.32	4.23	0.4100
9	Kaolinite ..	39.20	13.58	4.72	0.3475
25	Kaolinite ..	—	9.12	5.46	0.5987
14	Bentonite ..	73.40	145.03	56.56	0.3400
16	Bentonite ..	71.00	177.62	68.69	0.3868
17	Bentonite ..	87.40	189.84	70.32	0.3704
21	Bentonite ..	84.60	130.29	46.74	0.3588
Other Clays :					
6		28.00	69.18	22.28	0.3221
5		84.40	38.53	11.40	0.2959
				Mean Value	0.3811

It will be seen that there is absolutely no correlation with the so called clay (i.e. 0.001 mm. particle diameter) and base exchange capacity which correlates with specific surface as clear from the above table.

7. B. CHATTERJEE (Howrah) : *Physical, Chemical and Physicochemical Properties of Clay Minerals.*

The clay material, i.e., the active fraction of soils, is composed of one or more members of a relatively few groups of secondary alumino-silicate minerals, known as clay minerals. The common clay minerals in soils are : kaolinite, montmorillonite and illite. The clay minerals are crystalline in character and their crystal structures are definitely known. The kaolinite structure consists of a silica sheet fused with a single gibbsite sheet. The lattice structure of the minerals of the montmorillonite group consists of a gibbsite sheet sandwiched between two silica sheets with vertices pointing towards each other. The illite structure is practically similar to that of montmorillonite with the exception that about 15 per cent of the Si positions are replaced by Al and the resulting negative charge is balanced by K ions. The high base exchange capacity of the minerals of the montmorillonite group has been attributed to the isomorphous replacement within the lattice resulting in the development of negative charge which is balanced by exchangeable cations. No replacement within the lattice of the minerals of the kaolin group has been reported. The cation exchange capacity of the minerals of this group has been attributed to the existence of "broken-bonds" in kaolinites or to the H ions of the OH group. Illites have base exchange capacity intermediate between those of montmorillonite and kaolinites. In illites many of the cations are held between basal planes and are not accessible to exchanging cations. Increase in the base exchange capacity of illites on grinding supports this hypothesis.

Clay minerals are essentially of polar or electrochemical character. The interaction between a clay mineral and an added electrolyte involves the exchange of cations present in the electrical double layer surrounding the clay particles for the cations of the added electrolyte. The dissociation of cations from clays is found

to depend on the type of the clay mineral present and also on the nature of the cations involved.

Hydrogen kaolinites show a dibasic character within the range of pH 4.0 and 11.0. The ratio of the base exchange capacity at the two inflexion points is about 2.0. The first inflexion point in their potentiometric titration curves with NaOH usually occurs between pH 7.0 and 8.0 and the second one between pH 8.0 and 9.5. Hydrogen montmorillonites usually show a monobasic acid character. The NaOH-curve shows only one inflexion point between pH 7.0 and 9.0. The potentiometric titration curves of H-illite show three inflexion points.

Another criterion for the differentiating kaolinitic clays from montmorillonitic ones is based on the effect of addition of NaOH on the viscosity of aqueous suspensions of H-clays. Apart from a slight initial lowering the addition of increasing amounts of NaOH has little effect on the viscosity of kaolin suspensions while in the case of montmorillonites, the viscosity progressively rises, reaches a maximum value and then diminishes on the gradual addition of NaOH.

A third criterion has been obtained for estimating approximate percentages of illite and montmorillonite present in H-clays prepared from soils. This is based on the determination of K_2O and MgO content of these clays. Knowing the K_2O and MgO percentages, the illite and montmorillonite contents are calculated from their respective formulae.

A good correlation is usually observed between the chemical, electrochemical and viscous data with those obtained from X-ray and differential thermal analysis studies of clay minerals. These methods can therefore be requisitioned for the identification of clay minerals present in soils.

8 M. D. KARKHANAVALA and JAGDISH SHANKAR (Bombay) : *The Structure of Clay Minerals in Relation to Their Properties.*

The methods of studying the structure of clay minerals, by X-ray diffraction technique, and the results obtained are discussed. Since in the domain of clay mineralogy, X-ray methods are usually supplemented with auxiliary techniques like differential thermal analysis, these are also discussed in so far as they have a bearing on the major topic. The limitations of each of these methods are set forth.

Since the subject is fast developing, the different lines of development in structure determination and the results achieved are outlined and the future trends examined.

The dependance of the hydration-dehydration properties of clay minerals on their structure is critically examined, with special reference to the kaolin-, and montmorillonite-group of minerals. This discussion is extended in the case of montmorillonite-group minerals to inter-lamellar absorption and complex formation with water, inorganic cations and organic liquids. The applications of such complexes formed by inorganic cations, in atomic waste disposal and fission product separation are discussed.

II. FUTURE OF CINCHONA INDUSTRY IN INDIA

Chairman : PROF. S. R. PALIT, Calcutta.

1. S. MUKHERJEE (Calcutta) : *The Future of Cinchona Industry in India.*

The Cinchona Industry which was started in India nearly a hundred years ago is now facing a crisis because of the decline in the incidence of Malaria and the development of various substitute Anti-Malarial drugs. A rational formulation of the Quinine policy is therefore, of importance at the present moment.

The formulation of a policy for Quinine production involves several factors, both administrative and technical. It is our purpose to discuss mainly the technical aspects here, which in short are :—

- (i) The possibility of complete eradication of Malaria.
- (ii) Survival of Quinine in competition with the Synthetics as an anti-malarial drug.
- (iii) The possibility of developing other known uses of Cinchona Alkaloids.
- (iv) The possibility of developing new uses of Cinchona Alkaloids in medicine or industry.

The Medical literature as well as the chemical constitution and the known pharmacological properties of Quinine suggest that it should be possible to extend the field of utilisation of Cinchona Alkaloids in medicine. There seems to be a possibility of developing their uses in veterinary medicine also.

Cinchona Alkaloids also seem to hold out promise for utilisation as a raw material for certain chemical industries. The addition of a trace of Quinine to hydrogenated oils could possibly enable the detection of adulteration of Ghee by the fluorescence test.

I expect that other speakers will throw light on these and other aspects of this question.

2. A. Y. SWAMY (Ootacamund) : *Future of the Cinchona Industry in India.*

The Cinchona tree was introduced into this country by Mr. Celement Markham in 1860. The Cinchona Plantation industry in India developed very soon and very fast but had a fall in the nineties owing to competition from outside, mainly Ceylon. The Governments of Madras and Bengal, however, continued this industry as a Public Health measure.

After the World War II the indigenous Cinchona Industry suffered a set-back owing to competition from foreign Quinine and newer synthetic anti-malarials and also due to the gradually diminishing internal consumption. The Government of Madras and West Bengal, the pioneers and now the sole producers of Quinine in India, naturally looked to the Centre for protection and the Government of India have imposed almost a total ban on the imports of foreign Quinine and gradually restricted the imports of synthetic anti-malarial drugs.

Quinine has stood the test of time for over 3 centuries and has successfully held its own against numerous synthetic anti-malarials. It is, therefore, no wonder that Quinine is acclaimed as a Gift from the Gods and the only sure remedy yet known for Malaria.

The States of Madras and West Bengal have invested large amounts in this century old industry, the investment by the Madras State Government to-day being about Rs. three crores. Madras has about 9,600 acres under Cinchona and two Quinine Factories which can produce 60,000 lbs. of Quinine per annum. West Bengal is closely behind with about 5,200 acres of Cinchona and a Factory producing about 40,000 lbs. of Quinine per annum. This industry provides employment to over 6,000 mazdoors and many trained personnel of various categories. It will be a National waste if these assets are not utilised profitably.

No doubt the incidence of Malaria is decreasing due to extensive anti-malarial work, but it is too early to conclude that Malaria would disappear altogether or that Quinine will not be needed in future.

India is a vast Agricultural country and many unhealthy areas with very little population are now being brought under cultivation through new colonization, irrigation, etc., schemes, resulting in the increase of population in such areas and in increased potentialities for the outbreak of malaria. Many areas which were once highly malarial are said to be free from Malaria now but the possibilities of

sudden outbreaks of malaria cannot be ruled out as even in big towns and cities, the mosquito nuisance—like that of the house fly—has not yet been completely eliminated in spite of persistent spraying etc., with the latest insecticides. But the fact must be recognised that systematic efforts are being made to wipe out Malaria from the country.

The future for Quinine, merely as an anti-malarial, therefore, cannot be considered as being too bright and hence it is necessary to find out alternative uses for Quinine. The Government of India have already requested the Indian Council of Medical Research to take action in this regard.

Besides being the sheet anchor in the treatment of Malaria, Quinine can be used for other pharmaceutical and industrial purposes and it is highly necessary to undertake research in this direction. The following additional uses for Quinine have been suggested :—

- (1) In insecticide composition (moth proofing of fur, feathers, wool, felts and textiles.
- (2) In hair lotions and pomades.
- (3) as an analytical reagent for testing of carbon monoxide in blood, cellulose, phenol, hydrochloric acid, Sodium Carbonate in Sodium bicarbonate and also as an ingredient in silver polishing and cleaning composition.
- (4) In Hydrogenated oil industry for detection and prevention of adulteration of pure ghee.

The Medical Profession and the National Research Laboratories in the country should give their best attention to the maximum utilisation of Quinine whether for anti-malarial or other purposes which only research can decide and thus help the Cinchona Industry to continue its service to the country and stand by it in times of emergencies, when Quinine seems to be the drug, most sought for.

3 R. N. CHAKRAVARTI (Calcutta) : *Reorganisation of the Cinchona Industry in India.*

The 'quinine problem' has arisen due to increasing popularity of the synthetics and dwindling of malarial cases. Quinine is, however, still the drug of choice in certain types of malaria and has a number of other uses. Moreover, there is no guarantee that the disease will not flare up again. Hence total stoppage of the production of quinine does not arise, at the moment, particularly as it is an Indian product.

It will be of immense help to the Cinchona industry if some new uses of quinine is found out or if it is commercially possible to convert quinine into some other useful drug. But one should not count on such possibilities before hand. On the contrary, it would be wise to accept that in course of time quinine may have to give way. A drug usually has a limited life and quinine is perhaps no exception, although as a vegetable drug it may be in use for a much longer period than any of the synthetics.

Even if quinine goes out of the market it need not be accepted as the final victory of the synthetics, as there will still be plenty of scope left for other drugs of vegetable origin. In this respect there are enormous unexplored potentialities in this country. For proper utilisation of these, collaborative researches by workers in various related branches of science are necessary so that newer remedies may be available from vegetable sources. It is also desirable to replace the Cinchona industry by an industry, on a much larger scale, for the production of vegetable drugs so that the industry may be adjusted from time to time according to prevailing demand. The Cinchona industry may collapse, but a vegetable drug industry, having a dynamic outlook and supported by a good team of research workers, may survive through ages.

4. ANIL K. SIRKAR and M. L. BHOWMICK (Calcutta) : *Possibility of Cinchona Alkaloids in the Rubber Industry.*

With the advent of synthetic antimalarials, some of which are cheaper and more effective, Quinine Industry which employs more than 5000 people in West Bengal is facing a crisis. In addition to this a considerable amount of non-quinine alkaloids, which are obtained as bye-products during the manufacture of quinine is wasted.

The literature indicates possibility of developing worthwhile accelerators for rubber vulcanisation by introducing groups favourable to accelerating activity, such as amino, dithiocarbamic acid, thiourea and thiazole into different quinine variants.

Investigations were therefore, undertaken very recently in our laboratory. An A.C.S. mix was prepared using the quinidine sample, supplied by the Cinchona Directorate, Government of West Bengal and was cured at 155°C. Results of Tensile strength and elongation are very much encouraging though it is not as good as the well known accelerator Captax (Mercaptobenzothiazole). However, the work is in a very preliminary stage and deserves further exhaustive study because if a successful accelerator can be developed it may not only stabilise the quinine industry but also save a significant amount of foreign exchange by replacing a part of the imported accelerators. Further work is in progress.

I. TEACHING AND RESEARCH IN GEOLOGY AND GEOGRAPHY

Section of Geology and Geography

Chairman : DR. S. C. CHATTERJEE, Patna.

1. AJIT KUMAR SAHA (Calcutta) : *A Plea for Revision of the Present System of Undergraduate Teaching of Geology.*

Some of the glaring defects of the present system of undergraduate teaching and examination in Geology in most Indian Universities are :—

- (i) The student can afford to neglect his studies for the major part of the year;
- (ii) he can pass without having to cover the whole course; (iii) the system encourages 'cramming' and shallow thinking on the part of the students.

A thorough revision of the present system of undergraduate teaching and examination is suggested on the following lines :—

- (i) Each of the branches of Geology should constitute a course and the teacher or teachers of the College, teaching the particular course, should be the sole examining authority. The syllabus as at present, should be framed by the University—but this should be flexible.

- (ii) The examinations should consist of periodical class examinations, each covering small parts of the course and the students' work on specific assignments given by the teacher. In addition, there will be an annual examination covering the whole course, the proportion of marks between the term examinations to the annual examination being 50:50. There will be no final, University-conducted examination, as at present.

- (iii) The questions set should be more of the objective type; they should be framed so as to bring out the students' thorough comprehension of the subject.

- (iv) The pass mark for each course should be raised to 50% and First class marks to over 70%.

- (v) The practical examinations to be conducted jointly with external examiners as at present; a greater proportion of marks (at least 30%) should be assigned to the students' practical work in the laboratory and in the field.

It is contended that the suggested revision would remove the defects of the present system of teaching and evaluation. On the other hand, the revised system would make the College teachers more alert and responsible for maintaining a high standard and would create in them greater interest in teaching.

A plea is made also for imparting practical training in elementary workshop practice to all students of science including Geology students.

2. SAURINDRANATH SEN and ABANINATH CHAUDHURI (Calcutta) : *Teaching and Research in Geology.*

In spite of considerable improvement of conditions of teaching and research in our Universities during the last decade, the training imparted in Geology is far from satisfactory due to limitations imposed by the curriculum followed and the time available. There is no denying the fact that in producing work of fundamental importance, or in pursuing any sustained research we, both in the Universities and in the Government surveys, have shown rather poorly. Especially during the last fifty years we have not been able to keep pace with the phenomenal advance made in all the branches of our Science.

We have almost formidable draw-backs individually in respect of our intellectual equipment for higher research and collectively in our attitude towards it. Yet these are not half as formidable as the atmosphere and the conditions in which we work.

To remedy the appalling deficiency in training of potential workers, we would like to make the following suggestions: First to impart sufficiently broad-based training keeping pace with the rapid advance made in the different branches; secondly, as there is enough scope for expanding the curricula, to extend, in keeping with trends in other countries, the course of study in the under-graduate level for students majoring in Geology. As teachers, research guides and research workers, we have felt keenly the need in our students of a much more intensive knowledge in the fundamental science of physics, chemistry, and mathematics as well as in botany, zoology and statistics than is possible to acquire in the Pass B.Sc. courses. The only remedy is to introduce short-time courses in the Post-graduate level in all sciences for research students and teachers in allied branches. The course of studies in Geology in the post-graduate classes should be split into three groups (i) petrology, mineralogy and structural geology; (ii) palaeontology, stratigraphy and structural geology and (iii) applied geology. It is intellectually impossible for an individual in the post-graduate level to do justice to both petrology and palaeontology, two such entirely different aspects of the science which require not only different backgrounds but also an entirely different attitude and approach.

3. R. L. SINGH (Varanasi) : *Teaching and Research in Geography and Geology in India.*

Geography as a University subject has been very recently developed in India. The Muslim University, Aligarh was first to introduce postgraduate teaching in Geography in 1931, being followed by the Calcutta University a decade later. Today only eleven of the 35 Universities of the country are teaching geography at the postgraduate level, most of which introduced the subject after the Second World War. Geography has attracted the least attention of South India and is most popular in Uttar Pradesh.

In the words of Barrows "Geography is the mother of all sciences", but scientific geography is being just developed in the country; and at a few Universities geography is included in the Faculty of Science.

The first University chair in geography was created at the Banaras Hindu University as late as 1948 and at present there are only six chairs in the whole

country. And, the first University chair in geography in the world was established as early as 1820 at the University of Berlin, which was occupied by Prof. Ritter.

The teaching methods learnt in training schools/colleges are seldom practised in the schools owing mainly to lack of facilities and equipments. The spoon feeding methods are followed at all stages including the degree level. In some of the advanced countries like the U.K., visual aids and tape recorder etc. are used at even primary levels, while very few of our University Departments have all these facilities.

Geography is treated as an optional subject at all levels of education; a few states like West Bengal have, however, introduced geography as a compulsory subject at the high school level. In junior high schools, geography is treated as a part of social studies. Prof. Wooldridge considers this trend as to be 'taking ge out of geography'.

The courses need to be reoriented on scientific principles at all levels. The methods and standards of teaching must be improved at the Pre-University stages and uniformity of standards need be maintained at all Universities. Training in field studies and research techniques should be given at the post-graduate level.

Today we have over two dozen foreign trained and a large number of home trained geographers in the country. But the output of research, both in respect of quality and quantity, is relatively small. The researches in physical geography including geomorphology are quite insignificant. Most of the research work done covers the fields of Regional and Economic Geography, and land use, recently urban geography and geography of settlements seem to have attracted greater attention.

4. A. K. BANERJEE (Calcutta): *On the Integration of Teaching in Geology, Geophysics, Mining and Metallurgy for the Development of the Mineral Industry in India.*

The mineral industry for its development depends, in any country, on the level of competence of its geologists, geophysicists, mining engineers, and metallurgists. It is the geologist who nourishes the roots of the mineral industry. It is he who explores virgin country, obtains geological details and where necessary, with the aid of the geophysicist, locates mineral deposits, proves their worth and hands them over to the mining engineer for exploitation. The mining engineer, in his turn, works mineral deposits and maintains a continuous supply of raw materials for the metallurgist. The metallurgist puts the raw materials through different processes and produce metals for consumption in the industries. Thus the geologist, the geophysicist, the mining engineer and the metallurgist are members of a team to whom are entrusted the proper exploitation and utilisation of the mineral resources of a nation.

Since the geologist, the geophysicist, the mining engineer and the metallurgist form a team and normally work in a team it is but natural that their training should be so organised and co-ordinated as to develop the team spirit in them from the very beginning of their career preferably from their student days. The primary requisite for such development is that every Indian University imparting training in any aspect of the mineral industry should organise training in geology, geophysics, mining and metallurgy at one and the same institution, preferably an Engineering or a Technical Institute. The corresponding departments should be housed in adjacent buildings within the same compound. The separate departments should be co-ordinated by a Dean under the faculty of engineering or technology. The course of studies in these subjects should be co-ordinated and inte-

grated in such a way that the geologist, the geophysicist, the mining engineer and the metallurgist so trained can fit into a well geared team straight away and work for a common purpose.

Such a course of studies in geology should be properly designed as Mining Geology since it would be specifically geared to the development of the mineral industry and so should be distinguished from a course in Applied Geology which should necessarily embrace a broader scope of studies. A course in Mining Geology should run for about four years and should include instruction, up to suitable standards, in the following subjects :—Physics, Chemistry, Mathematics, Engineering Drawing and materials, Engineering Mechanics, Mining Processes and Practice, Surveying, Physical and Structural Geology, Mineralogy and Crystallography, Petrology, Stratigraphy and Palaeontology, Economic Geology, Geophysics, Soil Mechanics and Hydrology, Metallurgy, Mining Geology, Photogrammetry and Photogeology, Mineral Economics, English and another foreign language such as German, French or Russian together with practical and field classes.

5. R. N. P. AROGYASWAMY (Calcutta) : *Teaching and Research in Geology and Geography.*

Despite advance in the various fields of Geology no attempt has been made in many cases to provide scope particularly for specialisation like Geochemistry, Crystallography, X-ray structures, Ore deposits and Genesis, Thermodynamics etc., or Petrogenesis or Micro or Macro Palaeontology etc. No University can afford to introduce all subjects. This can be done if the Universities can combine and come to an understanding and with the liberal aid from the University Grants Commission arrangements for the interchange of students between Universities can easily be made.

One modification, which is long overdue, is the introduction of geomorphological concept of earth sculpture etc., in teaching general geology. This will be advantageous to students specialising in Engineering Geology, and Applied Geology. Inclusion of Photogrammetry into Photo-Geology would enable the geologists a bird's eye view of a large part of the country. Broad structural features are well displayed. Air-photos, in certain types of terrains become an absolute necessity, e.g., in the Garo Hills. It becomes an asset in locating oneself in the dense bamboo thickets or jungles.

The training, offered to students in applied geology and engineering, is also in need of modifications, in order to render it useful to the profession. In framing courses it should be remembered that the pattern in the training for the various professions is fundamentally different.

No standard text-book in Engineering Geology is available. The material required for teaching can be obtained from different foreign current literature on Engineering Geology.

In case of Applied Geology the courses are too comprehensive to be assimilated by the student. It will be necessary to modify the course somewhat to produce good top class mining geologists. In this connection it will be necessary to introduce a fairly substantial amount of geophysics and surveying in addition photogrammetry should be made compulsory and possibly included in a paper along with geomorphology.

The importance of field studies and training cannot be over emphasised. Degrees may be awarded only on completing at least four months field work, of which about three months will be devoted to systematic mapping.

6. S. M. MATHUR (Calcutta) : *Teaching and Research in Geology and Geography.*

Particular emphasis has been laid upon the teaching of Field Geology in Indian Universities. The field training scheme by the Indian Universities suffers for the following drawbacks :—

- (1) The junior teachers conducting field classes have themselves little experience of field work.
- (2) Due to paucity of funds no different types of geological areas are shown.
- (3) There is a general lack of suitable field equipment.
- (4) Most students (and, unfortunately, some teachers) take these field trips more in the light of picnics in which geology is only incidental.

The drawbacks enumerated above can be overcome if there are suitable instructors and adequate funds available to the teaching institutions. However, a few selected teachers are by now receiving practical field training conducted by the Geological Survey of India. Although this period is quite short, the camps are of great value in giving sound grounding in all respects of field geology.

Official surveys in many countries have an admirable system of employing teachers and graduate students on part-time basis. Some of the teachers, moreover, bring to the survey experience and abilities in their special fields. The Geological Survey of India could perhaps emulate the example of these surveys.

The mining industry could also help by arranging to give stipends to students to train with exploration staff of reputable firms.

The Universities must arrange for more field trips of the right kind. Long vacations along with working days should also be utilised for the same.

As regards finance the University Grants Commission, large mining companies and similar other bodies should be persuaded to assist.

7. PROF. G. KURIAN (Madras) : *Teaching and Research in Geology and Geography.*

The present state of teaching geology and geography is rather academic or even confined to text-books; and those text-books are unfortunately written by foreign authors to meet the needs of the students of their universities. That leaves our students in a very poor state of grounding. So it is very desirable that books are written from the point of Indian needs. Also these subjects should be given much more of field background so as to enable it more worthwhile and inspiring.

8. MANORANJAN CHAUDHURI (Calcutta) : *Teaching and Research in Geology and Geography.*

I would like to put forward a few points with regard to the teaching of geography in Indian collegés and Universities.

One cannot deny the fact, that reorganisation of the syllabii for effective teaching of the subject is urgently called for. But other things remaining the same, conditions may be considerably improved, if due emphasis (is) laid upon method of teaching.

Geography, like geology, botany and zoology is a field science. Unfortunately due emphasis is yet to be given to field work in geography in the colleges and universities in this country. Only the undergraduate and post-graduate students of the universities and colleges undertake some type of field work and that too in a sporadic manner. Incidentally, I have found students in our colleges evince great interest for field work, when due emphasis is laid on the same. Attention must, therefore, be paid to the method of study so that even the

beginner may feel interested in his field work. For instance, to start with an area that may be selected for such a study, may be a village, on the river, on a mountain, on a plateau as the case may be. Students concerned may be provided with questionnaire relevant to the particular area. They may be also asked to draw sketches and maps of the area concerned. The students should be given absolute freedom of preparing answers to such questions from their own imaginative audacity and vision. This would undoubtedly help in providing sound basis for acquiring higher knowledge in the subject. The course of field study may also be a graduated one beginning from the intermediate to the post-graduate level. But no such field work can be effective and systematic unless field work is included in the geography syllabii of the universities and proper marks are allotted for excellence in such work.

9. B. N. CHATURVEDI (Hyderabad) : *Teaching and Research in Geology and Geography.*

1. Since geography is also a school subject the responsibility of geographers is greater. The medium in schools is increasingly becoming the mother tongue or the regional language. There is a dearth of suitable text-book and it is time that geographers take in hand the enriching of the Indian vernaculars with up-to-date geographical literature.

2. The introduction of 'Social Studies' and general education in the school syllabuses is cutting at the very root of geography in schools. I have experience of three states in South India who have done away with geography as a compulsory subject and introduced social studies instead. The teaching of geography as an optional in groups of humanities will have to be made more attractive by frequent field works and visual aids. The study of local geography should be emphasised right from the lower secondary stage.

10. DR. S. P. CHATTERJEE (Calcutta) : *Teaching and Research in Geology and Geography.*

The patronage of the G. S. I. extended to the trained geologists has greatly encouraged the Departments of Geology in different universities. The numbers have increased. The syllabuses are too general and there should be special courses for post-graduate training in minerology, petrography, palaeontology and geomorphology. More emphasis should be laid on field work training.

Geography teaching started as early as 1924 at the Muslim University. The subject was included in the science faculty by the Calcutta University and the scientific bias to it was given in the following years. The new avenues which have opened in the field of planning have encouraged the teaching of geography in the universities. There should be an all-India body of Geographers and Government of India is requested to set up a Committee for reviewing geography teaching in different universities. The subject should be treated as a group of sciences as in the Moscow University and not one single subject. There should be post-graduate specialized courses in geomorphology, soil geography, cartography, economic geography and regional geography.

11. W. B. METRE (Digboi) : *Teaching and Research in Geology and Geography.*

Mr. Metre emphasised due necessity of paying more attention to quality, even at the expense of quantity and pleaded that unless we attract the best students to geological and geographical courses in the universities we may not be able to make much progress,

12. PAUL W. RICHARDS : *Teaching and Research in Geology and Geography.*

Impressions from association with Lecturers in Geology from twelve Universities in G.S.I. field training camp :

Value of courses in Engineering School (surveying, descr. geometry).

Field geology courses—in the regular school term, as well as special field courses.

Report preparation.

13. CHINTAMAN BALVANT JOSHI (Bombay) : *Teaching of Geography and Geology.*

Applied side of geography must be given weightage in courses of study. This can be done if marks are assigned for practical examination. Geography be assigned a place in the Science Faculty in all universities. Courses should be so framed as will open lines of employment in National Planning Sections in States, the Department of Meteorology and Industrial Concerns.

14. S. N. WAKHALOO (Patna) : *Teaching of Geology and Geography.*

1. What, with the need for introducing Hindi as a medium of teaching in Indian Universities, should be the alterations desirable to be introduced in the syllabus.

2. What, with the proposed introduction of Three Year degree course in Indian universities, should be the changes involved in the syllabii.

3. At the present time in most of the Indian universities, students take their first degree in geology only after putting in two year's work in the subject. In view of the need for imparting standard instructions in geology to our students, I think, it is only desirable to enforce the minimum requirement of four years training in geology after their matriculation examination.

4. There is a great need for having some sort of uniformity in the syllabii of various Indian universities. It is, however, understandable that there should be some elasticity in the courses of studies in conformity with the local talents available, but with all this I do feel that there should be some sort of standardization for putting into effect the minimum standards expected of students for obtaining professional jobs.

5. Should it be found expedient to have a change over to Hindi as a medium of 'Instructions' in Indian universities, I think it is now the time that we should seriously consider about the question of bringing about suitable texts in Hindi.

6. In view of the fact that the students do most of their courses at Matriculation level in their own regional languages, there is need to allow them the benefit of obtaining instructions at the university level also in the same language. The advantages of it are so obvious as not to necessitate me to make any special mention.

14. PROF. N. N. CHATTERJEE (Calcutta) : *Symposium on Teaching and Research in Geology and Geography.*

I have listened with interest the comments made by the previous speakers on the subject of teaching of Geology in Indian Universities. I find that the members are not very well informed regarding the actions taken recently by the India Government through the University Grants Commission in this important aspect of training of Post-graduate students in Geology. As I happen to be a member

of the Geology Committee of the University Grants Commission I am in a position to say something so that members present here might have the correct picture of the state of affairs in this connection.

Several members complained about the lack of equipments and adequate number of teachers on the staff. Regarding these points I may inform you that the U. G. C. always considers sympathetically the proposals submitted by the different Geology Departments of the Universities regarding these topics and makes suitable grants for the laboratory equipments, teaching staff (Professors, Readers, Lecturers) and building. In view of this I think it is unnecessary for the members here to raise comments on these items. But with regard to the teachers specially the lecturers in the different University Geology Departments I personally feel that the best talents are not available to the Universities on account of low pay scale of the lecturers (Rs. 250—Rs. 500) as recommended by the U. G. C. This nonavailability of the best boys has been due to their recruitment in the India Government Departments with better emoluments and future prospects. It is therefore rather very difficult to attract the best talents for the teaching profession in the universities and the only solution of the problem lies in the improvement of the lecturers' grade from Rs. 250—Rs. 500 to Rs. 350 to Rs. 850. This step if adopted will I think definitely improve the position and the Universities might be able to attract the best talents which are absolutely necessary for the teaching profession for obvious reasons.

I would therefore like to make a proposal before the house that it should adopt a suitable and concrete resolution recommending a suitable grade higher than what has been adopted by the U. G. C. for the lecturers. This resolution should be forwarded to the Executive Committee of the Indian Science Congress for transmission to the University Grants Commission for due consideration.

Regarding Syllabus of the M.Sc. Classes in Geology certain suggestions have been made by the previous speakers that a uniform Syllabus for all the University Geology Departments should be framed and that Inter University Board might be approached for the purpose. In this connection I can inform the house that U. G. C. Geology Committee had also gone into this question of framing suitable Syllabus for the Pure Geology and for the Applied Geology courses and a small Committee was also formed for the purpose.

As I happened to be a member of that Syllabus Committee I can tell you that after careful scrutiny of the Syllabus of the several important Universities the Committee was of opinion that the Syllabii were more or less of the same standard and that one rigid Syllabus for the M.Sc. Course for all the Universities need not be framed. The different University Departments might have their detailed working Syllabus for the purpose of teaching the subject in its different important aspects.

As Applied Geology Courses were being gradually introduced in the different Universities the Syllabus Committee framed a Syllabus in outline for the Applied Geology Course. In view of what has already been done in this connection I feel inclined to suggest that no action need be taken in this matter of standardization of Syllabus for the M.Sc. as the teachers of different Universities might be in a position to have their working Syllabus for teaching the important topics of the different branches of Geology.

Now with reference to the points raised by some members regarding the duration of the period of Applied Geology Course I may tell you that the U. G. C. Geology Committee definitely laid down the period of study of Applied Geology. The M.Sc. Applied Geology is a three years' integrated course after the two years' B.Sc. Honours and one year's course after the two years' M.Sc. Pure Geology. Or it may be two years' course after 3 years' B.Sc. Honours course but the course should be an integrated one.

Regarding the Geological Field Work of the students the U. G. C. Geology Committee has also made definite recommendation with regard to the Pure Geology and Applied Geology students.

Regarding the Geological Field Training of the Post M.Sc. students the Committee has also made certain recommendations and suggestions to the Geological Survey of India for undertaking the scheme of field training of these boys and you perhaps know that the Geological Survey of India has been able to give implementation to this scheme of field training of the Post M.Sc. students.

The Committee has also recommended to the Geological Survey of India to arrange for detailed geological field training for the junior teachers in separate camp under the guidance of suitable experts and I am glad to inform you that such a scheme has been introduced by the Geological Survey of India so that the teachers thus trained in geological methods might in turn impart training to the students of the departments of the respective Universities. It is therefore highly desirable that the University Departments should avail of this opportunity of training their teachers for the good of the generations of students.

A copy of the report of the U. G. C. Geology Committee has already been circulated amongst all the Universities teaching geology and I request the members to refer to that report for getting all the necessary information regarding the various points raised at this meeting.

Before concluding I would like to request the house once again to adopt a suitable resolution to up-grade the salary of the lecturers and to forward the resolution to the Executive Committee for transmission to the University Grants Commission for necessary action.

II. GONDWANA SYSTEM

Chairman : DR. S. C. CHATTERJEE, Patna.

1 C. NARASIMHA RAO and DIPANKAR NIYOGI (Kharagpur) : *Talchir Sedimentation—A Review of Published Literature.*

Talchir sedimentation started with Talchir glaciation in Upper Carboniferous times. Some idea about the configuration of the pre-Talchir surface has been given by Fox. Local reliefs of the order of a few hundreds of feet have been noticed on this surface. Origin of Talchir basins has been ascribed by some to pre-Talchir trough faulting. Others thought that deposition took place in natural depressions in front of the ice sheets.

Generally the Boulder Bed is followed up by the Needle Shales and then by Sandstones. In places, however, the basal Boulder Bed is followed up by Sandstones and then by Shales. The Boulder Bed is not always at the base of the succession and the presence of more than one boulder bed has been noted at many places. Thin bands of limestone interstratified with shale have been reported from two places.

Usually the Boulder Bed is a greenish silt packed with pebbles and boulders upto 40 feet in size. Some sort of a crude stratification is discernible in pebbles and boulders, while the matrix is usually always stratified, as well as there are abrupt lateral passages to and interstratifications with well-bedded sediments. It seems that all 'Boulder Beds' described in Indian literature represent water-sorted moraines. Needle Shales are made up of the same silty material which forms the matrix of the Boulder Bed. Generally they are mauve or greenish in colour and possess the splintery fracture which is very characteristic of them. Sandstones are greenish, mauve or buff-coloured rocks containing fresh angular felspar grains. The total thickness is usually a couple of hundred feet, the maximum on record being 2,000 feet.

A few undoubted glaciated pavements have been described and a few localities show well-faceted boulders and pebbles which also exhibit scratching, striations and grooving. Generally speaking, however, these direct evidences of ice action are absent, which fact lends support to the contention that the Boulder Bed is nearly always a water-worked till. Presence of boulders in fine-grained sediments has to be explained by ice-rafting.

Correlation between the boulders with their sources has supplied a basis for proposing certain general directions of ice movement. From this one can get a good idea about palaeophysiography of Talchir times.

Out of the sedimentary structures in the Talchirs mentioned in published literature, following are the chief ones: bedding planes, including regular inter-stratification suggesting rhythmic sedimentation; ripple marks; mud-cracking ('tessalated'); intraformational conglomerate. 'Trappoid' weathering of the silty Sandstones may also be mentioned here.

2. A. CHAUDHURI (Calcutta) : *Gondwana System.*

Limit of deposition :

The Gondwanas are chiefly platform deposits, occupying depressions of the shield area in detached basins and they are not confined in the main to the south of the Gangetic alluvium but extend much further to the north of it, spreading as far as the northern latitudes of 34°, 32°, 30°, 28° and 20°, to nearly 10° to the south in the Payen Ghat belt. They are also intermittently in contact with marine waters of the ancient oceans to the north, west and east, according as the earth movements have affected the mass of the Indian platform at different geological eras, so much so that marine bands are found inter-bedded with fresh waterbands within the heart of the peninsula.

Geological age :

The Gondwanas extend from the base of the upper Carboniferous to at least the Wealden of the lower Cretaceous; the lower limit of which is characterised by marine fossils in the boulder conglomerate of Talchir age in the Hasdo valley and in the lower speckled sandstone group of the Salt Range, and the upper limit is obtained directly from the floral facies of the Himmatnagar sandstone and indirectly from the faunal facies above and the Umia beds of Cutch, from the ammonite assemblage in the Budavada-Vemavaram beds, as also from the situation of the marine Utatur beds overlying the Utatur plant beds. Dating of the intervening beds as Palaeozoic, Triassic, and Liassic was arrived at by means of vertebrate remains in them.

Lithology of the Gondwanas :

Leaving aside the coal seams, the Gondwana deposits are primarily made up of sandstones, shales, with occasional bands of clay and limestones. Sandstones and shales comprise the chief components and these are so varied in nature and composition that only qualitative statements regarding them would not satisfy the criteria for rock-unit classification in many coal fields. The difficulties experienced in locating bounding surfaces of the rock-units has been felt by the pioneers in the field. Colour, texture, structure, peculiarities in the contents of mineral matter in sandstones (e.g. undecomposed feldspar in the Barakars, white quartz pebbles in the Mahadevas, etc.) were treated of more subjectively rather than exposing them to the objective analyses unravelling the cycles and patterns of sedimentation in the respective basins.

The generalised version of the Gondwana lithology suffers from the obscurity caused by the absence of quantitative petrological data of the type sections of the rock units.

Structure of the Gondwanas :

The Gondwanas are sheet-like deposits of wide-extent but with variable strike and nearly horizontal dip except in certain parts of the coalfields. They are also known to be folded, faulted, thrust, and acted upon by intrusive and extrusive igneous bodies of different generation. The phenomena of these deformatives are known from their effect impressed on the rock but they could not be distinguished from the general body of evidence and placed in geological time in conformity with the several tectonic pulsations which passed through these deposits on account of the absence of location of the 'key beds' in the general mass of the rock-units of the type sections.

Palaeontology of the Gondwanas :

Work on the Gondwana fossil organisms of the past century dating from 1833 onwards elicited an enormous range of information regarding the occurrence of marine and freshwater invertebrates, vertebrates and land plants. Fossil land plants have been depended upon in the main to subdivide and classify the system into a two-fold unit of more or less 10,000 feet thick in each half and characterized by two entirely different dominant floras. But within these two generalised divisions of the Gondwanas neither sufficient evidence was accumulated nor the requisite attention paid to effect a systematic classification of the rock-units (e.g. the Barakar group) both of variable thickness and of floral facies. Palaeontological information on the Gondwanas are as old as the eighties of the last century except for the remarkable work of late Prof. Sahni and his school in the present one. But the value of this stupendous labour on palaeontology for the purpose of correlation of the Gondwanas is practically nil because the geology was either invariably missing or poorly represented, if at all, in the accounts of the floras.

Classification and correlation of the Gondwanas :

Dr. T. Oldham classified the Gondwanas tentatively in the last sixties and his efforts were primarily directed to the creation of a 'provincial scale' for the Gondwanas of India, more especially conditioned by the absence of any standard scale in contemporaneous Europe to go by. The difficulties he contended and the situation he envisioned are true even to-day. A 'provincial scale' for the Gondwanas of India is needed as truly to-day as it did in the past, and attempts have been made in the past by Cotter (1917) and Fox (1931) but none have gone any deeper into the problem than merely summarising the data from both published and unpublished reports in the possession of the Geological Survey of India. Control of the type sections of the rock-units from which they were named is needed first, followed by tracing, measurement of beds and collection of relevant data from the same basin.

3. DIPANKAR NIYOGI and C. NARASIMHA RAO (Kharagpur) : *Aspects of Talchir sedimentation as noted in certain Gondwana Basins around Giridih and Madhupur, Bihar.*

Talchir sedimentation was studied in detail in Jainti and Sahajuri coalfields, respectively South and South-East of Madhupur, Bihar, in Burhai basin North-West of Madhupur (Niyogi, 1958); in Giridih coalfield, Bihar (Rao, 1957); and in Tarataur and Barakar basins, respectively South-East and South-West of Giridih.

The basal Boulder Conglomerate Complex (50'-100') is generally followed up by Shales (100'-200') and these in turn by Chloritic Arkoses (260'). The Boulder Conglomerate Complex is made up of a number of boulder conglomerate beds (fourteen at Burhai) which are stratified themselves, being interstratified with and varying laterally into mauve and/or green shales (sometimes needle shales) and mauve and green siltstones and silt shales. Interesting features noted in different members of the Boulder Conglomerate Complex are faceted pebbles with concave surfaces, abun-

dant ripple marks, intraformational breccias, plaster conglomerate, cross bedding, rhythmic sedimentation in sandstones and shales including laminated and varved silts, subaqueous sliding, abundance of rafted boulders in sandstones and shales, shrinkage cracks, penecontemporaneous deformation in layered silts. The sedimentary environment was deciphered from all these to be glacier front deposition, mainly outwash deposits varying laterally into and interstratified with glaciolacustrine deposits in small ice-marginal lakes. Alterations of Boulder Conglomerate—sandstone—shale represent oscillations of the glacial front. The overlying formation, shales and siltstones are generally mauve or green, at places changing to black along the strike and locally contain chart nodules. They are extensively mud-cracked and ripplemarked indicating that they are shallow water deposits by glacial streams subject to periodic uncovering. Clastic dykes are frequent in shales. The topmost formation, chloritic arkoses, show extensive current bedding and scour-and-fill structures, some of which show opposite orientation in succeeding layers. There are some pebble beds, all the pebbles being rounded. Both these formations may perhaps be interpreted as glacial outwash deposits laid down by braiding streams confined to definite broad valleys, the glacial front having receded quite far back. The climate warmed up somewhat during the formation of the chloritic arkoses.

In conformity with the Gondwana basins in general, in all these basins one side shows the unfaulted natural junction with Archaeans except in Giridih basin which is faulted on all sides. One interesting observation was that in the three basins which contain Talchir rocks only, i.e., Burhai, Taratanr, and Barakar, there are comparatively fewer faults and intrusives are altogether absent.

Regarding the origin of the basins, the idea that these are pre-Talchir tectonic troughs seems to be ruled out because of the absence of lateral wedge arkoses which would be expected. It seems more likely that they were natural depressions or valleys deepened in some cases by glacial scour. From the absence of the intrusives, it is suggested that Talchir sedimentation was, in the main, tectonic and faults probably originated by differential compaction of sediments. Tectonic control is likely to have been established towards the end of Talchir times. In practically all cases, the basins of deposition seem to have shrunk at the end of the Talchir period. One mystery is the total absence of a tillite, in the true sense of the word. The reason may be that the tillite which was deposited on higher ground has all been eroded while the glaciofluvial deposits, deposited in depressions outside the glacial limits perhaps escaped erosion, aided by downfaulting in some cases.

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4. R. N. P. AROGAYASWAMY (Calcutta): *Lower Gondwana Rocks of the Peninsula.*

If the isogamic contours (Glennie, 1957) are superposed on the geological map, it will be seen that the outcrops of the Lower Gondwana rocks fall to the north of the -60 mg. contour.

This remarkable feature immediately suggests the existence of a probable relationship between the downbuckling, postulated by Glennie, and the disposition

of the outcrops of the lower Gondwana rocks. A general steepening, of the gravity gradients, is noticed in the same regions, where the value may probably be of the order of -3 or -4 mgls/mile. This will indicate the existence of a deep-seated structure affecting the basement rocks—very probably fault or a large vertical intrusion of basic rock or sima (Auden, 1949). Since the contours of this downbuckling closely follow the isogamic contours, it is possible that the downbuckle, which undoubtedly affected the sima, appeared on the surface as a fault or a system of faults of great magnitude.

Even though the age of this faulting cannot be fixed with any precision, the upthrow was evidently to the south. Assuming the faulting to be pre-Gondwana in age, it is probable that some of the portions of the southern part of the Peninsula, forming the upthrow side, was capped by ice, while the northern or downthrow portion enjoyed a more temperate and humid climate, required for the luxuriant growth of vegetation. With the progress of pediplanation, the land surface was rapidly lowered in the southern portion. Added to this, possibly, local subsidences also enabled the upper Gondwana seas to invade the land, and extend southwards. Thereafter, followed the Cenomanian transgression and the subsequent marine incursions.

If on the contrary, the faulting was post lower Gondwana, even then erosion alone would be enough to account for the removal of the lower Gondwana rocks from the upthrow side.

Taking into account the disposition of the lower Gondwana outcrops, there is an apparent regularity in the pattern indicating a possible common tectonic origin.

These tectonic features are reflected in the following river valleys : The lower Narinada Valley; the upper Narmada and upper Sone valleys; the Mahanadi valley; the lower Tapti and Purna valleys and partly the Damodar valley. The alignment of these valleys is suggestive, therefore, that the primary compressive stresses, responsible for the development of faults in these basins, were oriented essentially in the North-South direction.

5. N. N. CHATTERJEE (Calcutta) : *Symposium on Gondwana System.*

On being requested by the President of the Section I have the pleasure and proud privilege to open the Symposium on the Gondwana System.

The Gondwana System was first proposed in the year 1872 by H. B. Medlicott and though sufficient amount of work has been done in India during all these years on its occurrence, lithology, economic geology and fossil contents we are even to-day faced with many problems with regard to its limit of deposition, classification, correlation, climatic conditions during the various Gondwana periods, palaeogeographical features, nature of sedimentation in detail, structural features, microfloral contents of the different formations scattered all over the different parts of India etc.

Regarding the limits of deposition we are not yet in a position to say definitely on this point particularly in the northern parts of the Indian region in the foot hill of the Himalayas. There is sufficient scope for further field work in these regions besides other areas to get more definite and specific knowledge regarding this topic.

It is a good sign that some amount of activities are going on in the different Universities and research Institutions in the study of the sedimentological features of the different Gondwana basins and several evidences are forthcoming from individual workers. But it appears to me that such attempts are only isolated and insignificant compared to the huge magnitude of the task before us particularly in view of the fact that there are so many Gondwana basins scattered all over India and that some of them are fairly large in regional extent and with

huge thickness of sediments. It is therefore highly desirable that this work on the problems of sedimentation in the different basins should be well planned and a team work should be started in order to obtain comprehensive data on a co-operative and co-ordinated basis so that a complete picture of the different basins might be prepared.

At present our knowledge regarding the detailed nature and variations of the lithological characters of the different sedimentary beds is rather very limited but due to the investigation that are now in progress at different centres we are gradually getting more detailed information on this subject.

Regarding the classification of the Gondwana System we are even now faced with the problem of coming to a decision with regard to a two-fold or a tripartite classification. A careful study of the palaeoclimatic conditions, sedimentological features, and of the nature of the macro and micro fossils besides the stratigraphical characteristics should be taken into account before a correct and scientific classification can be arrived at. I think sufficient evidence and data have not yet been at our disposal to make an attempt to solve this problem of classification. The difficulty of proper correlation of the different beds with the standard stratigraphical scale is still there and attempt should be made to solve the problem as soon as possible.

I may mention here about an interesting find of several plant fossils with close similarity with the fossil assemblage of the Karharbari Stage in the lower parts of the Barakár beds in the Kasta Colliery, Palasthali, Raniganj Coalfield which has been made by a research worker of the Geology Department of the Calcutta University thereby proving the existence of Karharbari facies in an area other than the Giridih basin where the Karharbari stage was first discovered.

Though sufficient information regarding the macro fossils from the different geological formations have already accumulated there is yet enough scope to add to our knowledge regarding this aspect. Regarding microfossils it may be pointed out that our knowledge in this respect is even now limited. There is a good sign however that several workers in various Institutions are engaged in the study of the microfossil content including spores and pollen grains of the Gondwana beds including coal seams. Several interesting results have been forthcoming. It is thus natural to expect that in near future we will be in a position to have much more clear picture than now regarding the variation of the flora from the lower horizon to the upper horizon of the Gondwana formations.

I have thus made an attempt to place before you some of the problems facing us with regard to the Gondwana System and I hope with the combined efforts on the part of the research workers in this country they will be gradually solved.

I would now have the pleasure of opening the Symposium and invite members present to come forward to take part in the discussion on the various topics of the subject.

III. CHARNOCKITES, THEIR GENESIS AND INFLUENCE ON TOPOGRAPHY

Chairman : DR. S. C. CHATTERJEE, Patna.

1. C. S. PICHAMUTHU (Singapore : *Charnockites, their genesis and influence on Topography.*

The main characteristics of the charnockite series are well known, and it is proposed, therefore, to limit the introduction to this symposium to only some of the more important features which are specially significant in the study of the origin of these interesting rocks. It could be stated in general terms that the charnockite problem has now shifted from the igneous province to the metamorphic field, since workers from many parts of the world have been finding more and

more evidences for the genesis of the charnockitic rocks by metamorphic processes.

The following are some aspects which have to be considered in any discussion of this questions :—

(1) *Mode of occurrence*—The distribution of rocks bearing the charnockitic impress is regional, though the typical rocks of the charnockite series may be found in bands or patches of varying dimensions. The charnockitic rocks are often crumpled and folded like Peninsular gneisses. A crude bedding has sometimes been recognised. Huge folds have also been noticed.

(2) *Rock association*—In the charnockite regions, the typical members of this series are often associated with such metamorphic rocks as leptynites, khondalites, scapolite-calc-granulites, &c. There is rapid variation from one to the other.

(3) *Mineral assemblage*—The minerals constituting the charnockites are characteristic of metamorphism. Recently Howie and Subramaniam have shown by comparative study of the orthopyroxenes and garnets in the acid and basic charnockites near Pallavaram that these rocks could not have originated by differentiation from a magma.

(4) *Variations in chemical composition*—Many attempts have been made to attack the problem from the chemical point of view. According to Holland, the intermediate varieties were fairly constant in composition, and so he came to the conclusion that the original charnockite magma was of this composition from which the acid and basic rocks differentiated. Recent work by Howie has, however, shown that the intermediate rocks are not as constant in chemical composition as Holland thought, and so the parent magma has been considered by him to have the composition of a norite.

In such a heterogenous assemblage as the charnockite series with bands, schlieren, patches, and inclusions of varying petrographic types, chemical analyses of grab samples cannot but prove to be misleading.

(5) *Metamorphic stage*—The geological structure of Mysore State is an eroded anticlinorium pitching in a north-north-west direction, and so the deeper portions of the earth's crust are exposed in the South. There is a general correspondence also with increasing grades of metamorphism as one proceeds from north to south, and it is seen that the charnockitic rocks occupy the extremely southern part of the State, leading further south in the Madras State to the massive outcrops of the Nilgiris, Shevaroys &c.

The speaker believes that we have in south Mysore the northern fringes of the front of charnockitization, and the transition stage is represented by what have been described by Jayaram as "pseudo-charnockites" and "quasi-charnockites", rocks which have the appearance of charnockites without containing the characteristic mineral hypersthene.

In many parts of Mysore the gneisses associated with the charnockites do not contain hypersthene, but the quartzes are full of dusty and acicular inclusions, and the feldspars contain perthitic inclusions and myrmekitic inter-growths.

(6) *Age of charnockites*—Holland regarded the members of the charnockite series as part of the Archaean complex, and placed them in the upper Division. According to Smeeth, the charnockite intrusion took place after the Peninsular gneiss was formed and prior to the emplacement of the Closepet granite. Both Vredenburg and Rama Rao consider that the charnockites are contemporaneous with the intrusive period of the Closepet granite.

The speaker has pointed out that two distinct types of charnockites can be recognised—one, a gneissic foliated rock greatly resembling Peninsular gneiss, and another, a fresh coarsely crystalline granitic type. He has suggested that though both are Precambrian, the two types are of different ages on the evidences afforded by the intervening basic dykes containing clouded plagioclase feldspars.

(7) Attention was also drawn by the speaker a few years ago to the fact that enderbites containing plagioclase are very common in Mysore, a fact which is reflected in the chemical analyses by predominance of soda over potash. Recent work by Subramaniam has shown that in the Pallavaram area also there are enderbites. In South India, including the above mentioned areas, there are typical charnockites containing potash feldspar. In the opinion of the speaker this indicates the occurrence of two types of charnockites. It may well be that the earlier gneissic types is enderbitic, and the later palingenetic type is potash rich.

(8) *Influence on topography*—The charnockite massifs form some of the most elevated regions of the Peninsula. That they have been uplifted is indicated by the occurrence of trapshotten zones. The speaker has recently identified true glasses in the trapshotten charnockites near Madras. Natural glasses are practically unknown in pre-Tertiary rocks, and the occurrence of such glasses, therefore, dates the upheaval of at least certain blocks of charnockite as probably Tertiary.

Sketch maps of part of Mysore State were shown to illustrate the basic dyke pattern of Mysore State, the distribution of dykes with clouded feldspar and those with clear feldspars, and the relationship of clouded dykes to the charnockites which indicate that the clouded effect was present in dykes occurring in a zone in front of the charnockite region, and in general conformity with the structural pattern of the Dharwars.

In reply to several points raised in the discussion, Professor Pichamuthu made the following observations :—

Professor Chatterjee would like to know whether any typical 'igneous' charnockites have been recognised. It all depends on what is meant by the term igneous. Charnockites of intrusive aspect are known and they are probably of palingenetic origin. No satisfactory evidence has been produced to postulate an original charnockite magma from which the members of the series have been formed by differentiation.

Professor Rode's suggestion that interaction of a hornblendic magma with the country would produce charnockites has not been borne out by the speaker's experience in the charnockite region of South India. Reference was made to charnockite dykes. These are none other than the normal dykes of Dharwar age which have been metamorphosed. It is significant that the contacts are not quite sharp with the country and selvages are conspicuously absent. The trends of these dykes are generally concordant with the regional strike of the charnockites.

Mr. Krishnaswamy has observed that in many areas charnockites are rich in biotite. There are two ways in which biotite may arise in these rocks. One is by retrogressive metamorphism. It could also arise as an 'original' mineral, if the metamorphism took place in not so 'dry' conditions as to form the strictly characteristic minerals of the charnockite facies.

The observations made by Mr. Narayanaswamy regarding the geo-synclinal nature of the peninsular charnockites does not throw any new light on the problem of the origin of charnockites. It is recognised that the Dharwar sediments are geosynclinal in origin, and some of the charnockites have certainly been derived by their metamorphism.

Mr. Albers pointed out the E-W trend of the Nilgiri charnockites, and the parallelism between the quartzites and charnockites. These are borne out by observations in southern Mysore. The north-south trend is abruptly cut by the east-west trend, the contact in many places being characterized by intense mylonitization. In the Biligirirangan Hills, typical Dharwar members like quartzites and ferruginous quartzites are found within the charnockite field, running parallel to the general strike of the charnockites. He entirely agreed with Mr. Albers that the charnockite problem should be tackled in the field.

Mr. Sen's inference that the term 'regional' was applicable only to India was not correct. This term was used to describe all the regions of the world where charnockites were found. What was implied was that the occurrence of charnockitic rocks was not of small local nature, but wide-spread in certain areas and therefore **regional in extent and location**.

The occurrence of charnockitic rocks beyond Fermor's charnockite province is not difficult to understand. The boundary should not always be considered as an almost abrupt vertical plane. This is probably true only of areas where trap-shotten material characterizes the contacts. In other places, it may well be that the boundary is not greatly inclined to the present surface of the country and so it is possible for 'islands' of charnockite to be found well beyond the recognizable limiting zone between the charnockitic and non-charnockitic regions.

With reference to the observation regarding clouding, it was pointed out that the clouding in plagioclase feldspars was found only in the earlier stages of metamorphism and that it diminished with increasing metamorphism, disappearing **entirely in the granulitic facies**.

2. T. M. MAHADEVAN : *Symposium on 'Charnockites and their Origin'.*

T. M. Mahadevan referred to the Charnockitic rocks occurring in the area around Raghunathpur, north of Adra and pointed out that to the South of Adra, mapping of the area has revealed metadolerites in different stages of transformation to hypersthene granulites. The original doleritic texture is still preserved in some of these intrusives. These findings lend support to the view that, under conditions of the granulite facies basic intrusives could be transformed to basic charnockitic rocks.

An interesting feature in these dykes is the clouding observed in the plagioclase feldspars. The clouding disappears by recrystallisation in the typical granulites. This feature has a bearing on the problem of two periods of charnockites postulated by Dr. Pitchamuthu in Mysore.

Dr. Pitchamuthu has postulated two periods of charnockites on the basis of the presence of clouded feldspars in some of the dykes, later than the charnockites of the first period. Clouding of feldspars has been taken by him as an evidence of the second period of metamorphism. But the evidence from the rocks in the Adra area reveals that clouding disappears under conditions of the granulite facies. The presence of clouding in the Mysore dykes is, therefore, suggestive of the second period of metamorphism having never reached the intensity of the granulite facies.

3. S. NARAYANASWAMI (Calcutta) : *Charnockites—their genesis and influence on topography.*

Extensive geological mapping in Tinnevalley and parts of Coimbatore, Nilgiris and other districts in Madras and along the eastern ghats and east coast of Andhra and Orissa, which form the main Charnockitic region of Peninsular India, indicates that the hypo-metamorphic Charnockite-Khondalite suite of rocks belong to the oldest Precambrian formation in India, showing more than two periods of folding and deformation, granitic intrusions and metamorphism, in relation to the Aravalli, Sausar, Gangpur and Iron-ore series as well as the typically iron-bearing Dharwar rocks of Mysore and other parts. Detailed stratigraphic, structural and tectonic studies further indicates that the assemblage of rocks in the Charnockite-Khondalite Province belongs to a particular geosynclinal facies. The general rock types in the Charnockite-Khondalite Province are quartzites, magnetite-quartzites, crystalline limestones and calogranulites, pyroxene granulites (diopside-hypersthene-

hornblende granulites), garnetiferous quartzites, garnet granulites, Khondalites (garnet-sillimanite-graphite gneisses and schists), mica and hornblende gneisses, acid, intermediate, and basic charnockitic rocks and hypersthene-bearing hybrid gneisses, granitic gneisses and granites. All the rock types belong to a conformable stratigraphic sequence with associated extrusives and intrusives, and show a general parallelism of bedding and foliation, except for late tectonic granites. The charnockitic rocks nowhere reveal any clear-cut intrusive character. The above assemblage of rocks, therefore, suggest "eugeosynclinal association" consisting of pure and impure charts, ferruginous charts, pure and impure carbonate rocks, argillaceous and arenaceous sediments, graywacke sandstones, and associated flows of basalt and and intrusive sills, sheets and dykes of gabbro and dolerite. The widespread occurrence of intermediate charnockites, corresponding in composition to Precambrian graywacke, suggest their derivation from such sediments. The basic charnockites correspond to basaltic flows and intrusive gabbro and dolerite, which are prevalent rocks of "eugeosynclinal association". The said types correspond to acid granitic intrusives, or probably to an acid charnockitic magma. The genesis of hypersthene-bearing charnockitic rocks is, therefore, metamorphic, derived from deep-seated hypometamorphism under granulite facies, of rocks belonging to a "eugeosynclinal association". The retrograde changes noticed at places in these rocks are probably related to repeated period of deformation and metamorphism undergone by the rocks.

4. JOHN P. ALBERS (U.S.A.): *Charnockites—their original and physiographic effects.*

The distribution, structural and stratigraphic relations, fabric, and composition of the charnockites suggests that they may be high grade metamorphic representatives of sedimentary rocks as suggested by Mr. S. Narayanaswami. If we restrict ourselves to the "acid" charnockites it appears to me that they could have been derived from impure argillaceous quartzite or siltstone; and their distribution in the Nilgiris and Southern Mysore can be readily explained if they occupy the core of the northward-plunging anticlinorium described by Dr. C. S. Pichamuthu, the northward boundary of his charnockite area has a highly suggestive V-shape and the tip of the V (pointing north) occupies its proper position in the northward-plunging anticlinorium if the acid charnockites underlie part of the Peninsula gneiss, which in turn underlies Dharwars. The Nilgiri range is a synclinal cross-fold normal to the anticlinorium and occupied by charnockite. Small bodies of charnockite in Peninsula gneiss may be folded into the gneiss in the complex anticlinorium.

The fabrics of about 15 specimens of acid charnockite from various places in Mysore and Madras examined by me appear to be exclusive metamorphic. Thus it seems that fabric by itself will not yield conclusive evidence on the parentage of the rock (i.e. whether igneous or sedimentary).

Some geologists have noted that the charnockites do not show cross-cutting relationships to adjacent rocks, as might be expected if they were of intrusive origin. Inch-scale maps of charnockite areas by GSI and Mysore geologists also indicate markedly conformable relations between charnockites and adjacent rocks, again suggesting that the charnockites may be sedimentary rather than igneous origin.

The answer to the charnockite problem seems to be to lie in the field rather than in the laboratory, and the above comments are offered in the hope that interested students of the charnockite problem will devote more time and effort to the structural and stratigraphic studies in charnockite areas.

S. KRISHNASWAMY (Calcutta) : *Charnockites—their origin and physiographic effects.*

A part of the North Arcot district contained in toposheets 57P/1, 57P/5, 57P/9, 57 0/4 and 57 0/8 was mapped by the author. The main rock formations met with in toposheets 57P/1, 57P/5 and 57P/9 include :—

(Arranged in descending order)

8. Soils and sub-serial deposits
 7. Alluvium
 6. Basic dykes (Cuddapah)
 5. Pink gneisses and granites (equivalent to Closepet granite Post-charnockite age)
 4. Leptynites
 3. Charnockites
 2. Banded haematite quartzites and ferruginous quartzites (Dharwar rocks)
 1. Older gneiss.
- } Charnockite series

The older gneisses are nowhere developed in force, but where found form the basement complex. There are also only a few exposures of Dharwar quartzites, banded haematite quartzites and hornblende schists.

The rocks of the Charnockite series are even grained oily grey, bluish grey or dark grey coloured rocks with usually a good granulitic texture. They generally show a mural jointing : they are usually biotite rich rocks with hypersthene, quartz, microcline or an acid plagioclase felspar like oligoclase-albite as the essential constituents and the ores of iron (magnetite and ilmenite) and apatite as the common accessories. In rare cases, prisms of zircon and grains of pink garnets may also be present. These rocks carry often myrmekitic quartz especially in the more acid varieties of charnockites. Frequently, wavy extinction and strain shadows are seen in the quartz and felspar grains. In the more acid varieties the rhombic pyroxenes may be totally or partially absent, but biotite is an invariable constituent. Some charnockites carry also a brownish green hornblende formed possibly by the uralitisation of the pyroxenes. Some of the charnockites show a foliated and perceptibly "banded" structure especially in hill Δ 949, near Arunkunram village.

The rocks of the Charnockite series are commonly intruded by basic dykes, the dolerites and the norites, the former being more common. The pink coloured biotite gneiss and granite gneiss show also an intrusive relation to the Charnockites. The author believes that these gneisses and granites should be equated with the Closepet granites of Mysore.

In one locality lying about a mile to WNW of Selamanattam ($12^{\circ} 48'$; $79^{\circ} 12'$), rocks simulating the Charnockites have been recorded at the contact of a basic dyke (dolerite dyke) with the biotite gneisses : very similar rocks at such identical contacts have also been recorded from the top of hill Δ 1417 (sheet 57 P/1) to the north of that peak. The rock collected from this contact carried abundant biotite with subordinate amount of enstatite, hypersthene, orthoclase, felspar and smaller proportions of albite-oligoclase; limonite was the common accessory while apatite and garnets were the rare accessories. This may be suggestive of a possible origin for the charnockitic rocks.

The leptynites (which are richly garnetiferous rocks) appear to have been formed by the alteration of the Charnockites : the gradual passage of the Charnockites into the leptynites have been noticed in a number of sections on the slopes of the high hills east and east-north-east of Vellore town. In places the leptynites are either highly quartose or feldspathic. Norite dykes are common at or near such junctions between the leptynites and the Charnockites but in places the norite dykes have been noticed also to cut across the leptynites and Charnockites.

The pink granites and gneisses appear to be the equivalents of the Closepet granites; they are intrusive into both the charnockites and leptynites. The dolerite dykes of these areas are definitely younger than the pink granites and gneisses and are probably of Cuddapah age.

In the Shevaroy hills near Salem, Charnockites and a highly felspathic and weathered type of leptynite are found: only the bands of quartzo-felspathic leptynites have been capped by laterite and no "in situ" lateritisation has been observed over the Charnockites. These Charnockites are typical pyroxene granulites and gneisses and unlike in the North Arcot district biotite is not usually observed in these rocks. But the Charnockites and the leptynites of this area are highly varied in composition which has been reflected in the highly heterogeneous nature of the lateritic cap as well.

From his studies in Orissa (Angul area), in Andhra and in Madras states, the author believes that Charnockite is not a specific rock type but represents a process of metamorphism of rocks of both igneous and sedimentary origin. He does not, however, subscribe to the view of these rocks having been formed by the metamorphism of only the older peninsular gneisses and he feels that there is very little justification for including the rocks of the Charnockite series in a separate petrographic province. The Charnockites do not fit into any of the well-known petrographic provinces of Dr. Paul Niggli. The origin of Charnockites appears to be in diverse ways.

I. DISTRIBUTION PATTERN OF PLANTS IN INDIA

Section of Botany

Chairman : DR. R. MISRA, Banaras.

1. E. K. JANAKI AMMAL (Allahabad) : *"Distribution Pattern of Plants in India."*

The present distribution of a species, a genus or a family is determined by many factors. While climatic, edaphic and environmental factors act like a sieve to eliminate those plants which are incapable of surviving the environment, we have also to consider larger and more ancient factors that are responsible for the present day distribution of certain genera and families of plants. Thus the study of ancient land connections and palaeo-climates and changes in the position of oceans, mountains and continents have to be considered when we try to interpret the mozaic of plant distribution.

The total number of species of flowering plants of the world to-day is about 200,000 of which India has 21,000 i.e., more than one-tenth of the total species. In spite of this large number of species in India, a lesser number of endemics are found in India than in countries like, Australia, South Africa or China. The Flora of India has many affinities with its surrounding countries. In tracing the distribution patterns of plants in India, it is very necessary that this pattern be linked up with that of surrounding countries as in many instances the distribution of a genus or even species found in India is continued to one or other of the surrounding countries. We now have evidence that Peninsular India formed part of the gigantic continent of Gondwana which broke up only after the evolution of flowering plants. Parts of it now form the continents of South America, Africa and Australia. The analysis of several genera undertaken has distinctly shown this connection.

The Flora of India which is termed Indo-Malayan, is in character, a typical monsoon Flora. The prevailing type is controlled by the degree of rainfall and the period of dryness. A higher rainfall and short dry period will raise the Forest type to the

climax which is that of the Humid Tropics. The Forest Types of India, as described by Champion, is closely linked to the rainfall.

The analysis of the Flora of the recently formed Gangetic Plain reveals very interesting episodes regarding the migration of plants from the surrounding areas.

We have to-day many methods by which the distribution patterns of plants can be analysed and of these, the genetical analysis is most revealing from the point of view of the evolutionary life of a family or genus. The changes that have taken place in the course of eons of ages upon a genus and the relationship that existed between it and closely related genera can be traced by chromosome number, morphology and chromosome behaviour. When this is done for a number of families then the pattern of distribution becomes an indicator of not only the movement of the plant in the region but of the evolutionary movement of genes that go to make up a particular genus within a family. Such a study is as necessary as the study of the influence of the environment on distribution patterns of the plants of India.

The alternation of dry and hot period with an intervening fairly cold winter period in the northern regions of India makes it possible for the overlapping of several Floras composed of annual plants in the course of a single year. When distribution patterns of these annuals are studied in detail they are found to link the Flora of India with the hotter regions like Africa on one side and the colder regions of Siberia and Western Europe. This seasonal changes in the Flora of India have not been properly examined. Though distribution have been studied from the point of number of species, these have not been analysed genetically.

The papers presented fall into three groups :

- I. Those dealing with the distribution of plants in the major regions of India.
- II. Those dealing with the composition of the Flora of special regions with special edaphic characters.
- III. The distribution pattern of single genus or species.

2. ROLLA SESHAGIRI RAO and G. PANIGRAHI (Shillong) : *Distribution of Vegetational Types and Their Dominant Species in Eastern India.*

The distribution of important vegetational types met with in the different parts of the Eastern India comprising of Orissa, Bihar, West Bengal, Assam, Sikkim, North East Frontier Agency, Manipur and Tripura, visited by the Eastern Circle of the Botanical Survey of India upto September, 1958 for purposes of botanical collection and study, have been discussed in the paper.

Within the framework of the classification of vegetational types, traditionally based on altitude and latitude, the different areas visited have been ascribed to one or more of forest types and their different dominant species components have been enumerated and discussed, thus illustrating the well-known inter-relationships between "vegetation and flora".

The all important role of biotic factors in transforming the climatic climax and arresting the development of evergreen or semi-evergreen type at the grassland stage as observed in parts of Tirap Frontier Division, NEFA and in Nongstoin and other areas of the Khasi & Jaintia Hills of Assam where at certain higher and suitable elevations terminating into Pine forest; and also the influence of edaphic factors in the development of extensive grasslands in Motharguri (North Kamrup Reserve) and Kaziranga Reserve of Assam, with over 4m. tall grass species of *Sclerostachya usca* and *Saccharum spontaneum*, have been explained. Similarly, notes on the development of small pockets of unusual forest types not characteristic to those altitudes mainly due to the effect of local micro-climate have been added.

The distribution of some of the rare and interesting species in Eastern India, namely, *Gnetum*, *Nepenthes*, *Drosera*, *Dischidia*, root parasites like *Balanophora*, *Boschniakia*, and *Aeginetia*, stem parasites like *Viscum*, *Taxillus*, *Dendrophthoe*,

Helixanthera and saprophytes like *Monotropa* and *Galeola falconeri*, interesting Orchids like *Phajus miskmiansis*, *Vanda caerulea*, medicinal plants like *Rauwolfia*, *Podophyllum*, *Coptis*, *Fritillaria* and the like, have been indicated.

3. B. N. MULAY (Pilani) : "Vegetation Patterns of Rajasthan".

Deserts are places of violent contrasts and climatologically the desert is an area characterised by extremes of temperature, extreme aridity and having sparse population. In fact many factors must be considered for determining the climate and the vegetation of a given tropical country. The rainfall is the most important factor in addition to which the following should also be considered. They are (1) relative humidity, (2) evaporation, (3) evapo-transpiration, (4) mist, (5) dew, (6) cloud amount, (7) period of rainfall, (8) rainfall frequency, (9) intensity of rainfall, (10) length of the dry period, (11) temperature, (12) insolation, (13) wind and its distribution, (14) altitude, (15) nature of the soil, (16) water retaining capacity of the soil, (17) temperature of the soil, (18) sunshine, (19) influence of the grazing animals, and (20) the influence of pests.

Contrary to the general belief that very little work has been done on the vegetation of this part of the country, we find a considerable amount of work has been done on the vegetation.

If we survey this work we find that the dominant common plants in the Bikaner area are *Gymnosporia montana*, *Calligonum polygonoides*, *Prosopis spicigera*, *Zizyphus rotundifolia*, *Capparis decidua*, *Salvadora persica*, *Aerua tomentosa*, *Leptadenia pyrotechnica*, *Crotalaria burhia*, *Tephrosia purpurea* and some others of minor importance.

In Shekhawati area in Eastern Rajasthan, we get dominant plants like *Capparis decidua*, *Gymnosporia spinosa*, *Salvadora persica*, *Prosopis spicigera*, *Calligonum polygonoides*, *Zizyphus rugosa*, *Balanites aegyptiaca*, *Ephedra foliata*, *Leptadenia pyrotechnica* and others.

In Jaipur area in East Rajasthan we get the following dominant plants, *Anogeissus pendula*, *Boswellia serrata*, *Gymnosporia spinosa*, *Adhatoda vasica*, *Calotropis spp.*, *Euphorbia royleana*, *Tephrosia purpurea*. Sometimes we also get *Acacia senegal*, *Acalypha malabarica*, *Portulaca quadrifida*. In Lohargal area at about a height of 500 feet, we get trees like *Bauhinia spp.*, *Grewia populifolia*, *Holoptelia integrifolia*, *Mangifera indica*. At a height of about 2,000 feet at Harsh Nath we get the following trees, *Anogeissus pendula*, *Salvadora persica* and *S. oleioides* and *Cedrella toona*.

At Khetri almost all the common plants of Jaipur area are found; in addition, in the marshes we get *Typha angustata*, *Cyperus eleusinoides*, *Panicum spp.*, and the orchid *Zeuxine sulcata*. These are found in different seasons of the year. The chief common plants of the rainy season in this area are *Cardiospermum halicabum*, *Melothria spp.*, *Daemia spp.*, and *Momordica spp.*

The chief hydrophytes of this and other areas include *Vallisneria spp.*, *Hydrilla spp.*, *Potamogeton spp.*, and others. The Pteridophytes, Bryophytes and Algae are badly represented. We get a few ferns like *Actinopteris dichotoma*, and *Adiantum spp.* A few species of *Riccia* and a few algae like *Fritschella-tuberosa* and other *Chlorophyceae*.

I think we are justified in drawing the following conclusions after the careful study of the vegetation :

- (1) That the Rajasthan desert is an absolute desert is a debatable point.
- (2) The present vegetation of Rajasthan is the product of deterioration of a once rich vegetation present in this part. Climatic factors might have operated in this deterioration, but an equally important and prominent part is played by the unrestricted grazing by the principal livestock animals.

- (3) The richer plant communities of Eastern Rajasthan gradually become thinner and thinner as one approaches the western part of Rajasthan.
- (4) The vegetation of southern regions of Aravalli ranges is more complex than that of the north.

4. R. K. ARORA (Poona) : *Distribution Patterns of Some Plants from Western Ghats.*

Western Ghats provide interesting type of vegetation varying from rich evergreen forests to dry deciduous and scrubby jungles. Depending upon (a) the amount of rainfall, (b) the type of rock and (c) the nature of the soil, the composition of the flora differs, thus exhibiting a variation in the distribution patterns of the plants met with along this belt. In this paper attempt has been made to give the general pattern of distribution of the evergreen flora, particularly from the humid tropics of the Western ghats, by taking a few exemplary types. Distribution patterns of the various species from the following genera have been discussed :—

Garcinia, Clochidion, Litsaea, Polyalthia, Diospyros, Vitex and *Myristica*.

The humid tropic flora has many endemic species confined to the western ghats as has been indicated in this paper ; and to upper Assam, and only a limited number of species are distributed elsewhere in India. On the basis of the distribution patterns of the above plants, following conclusions have been drawn for the distribution of the flora of the Humid tropics of the western ghats :—

- (a) The flora has a good deal of Malayan element in it.
- (b) It shows affinities to a great deal with the flora of the upper Assam and next to it,
- (c) to some portion of Bengal in the eastern peninsula, and
- (d) Western Himalayan element is insignificant.

Humid tropics corresponds to specialised conditions characterised by high humidity, high rainfall and high temperature. Such conditions are elsewhere existing in Upper Assam and only to a relative degree in the eastern peninsula; and also in Malaya. So, the affinities of the flora of the humid tropics of the western ghats with these regions is obvious.

In the western Himalayas, the conditions are altogether different and accordingly the humid tropic element is missing from here.

5. B. M. WADHWA (Poona) : *Distribution Patterns of Some Plants of Central India.*

The floras of Central India shows a wide range of distribution, with very few endemic species, depending upon the nature of the rock, soil, climate etc. It is noted that the majority of the plants from these areas are met within the Deccan Trap Country and along the western ghat in areas which supports vegetation on granite and gneisses.

The alluvium supports species like *Tectona* and others which show quite an interesting distribution; *Butea* is still another interesting species and its distribution is varied.

The present paper deals with the distribution patterns of few dominant tree species of this area viz., *Acacias*, *Butea frondosa*, *Anogeissus*, *Terminalia*, *Tectona*, *Ougeinea*, *Odina woodier* and *Grewia tiliaefolia*.

The distribution of the above plants is given in the paper. It suggests the affinity of this flora more with trap country, some parts of eastern and western ghats and Ceylon. The similarity obviously can be correlated on the soil, rock and climatic factors. The Himalayan elements is almost lacking.

6. S. K. JAIN (Poona) : *Distribution Patterns of Some Plants of the Deccan Trap.*

The Deccan Trap country within the districts of Poona, Satara, Sholapur, Ahmednagar and Thana presents interesting instances of distribution patterns of plants.

The area is formed of irregularly shaped hills, plateaux and plains. This variety of habitats makes the area a favourable ground for growth of a large number of species.

A number of genera which are regarded as of outstanding representation in Asia—Australia region (Good, 1947) are found in this area e.g. *Acacia*, *Diospyros*, *Zizyphus*, *Gnetum*, *Ficus*, *Ixora*, *Sterculia* etc. The list of their species in Deccan Trap is given.

The following plants are some of the commonest and dominant tree and shrub species of the flora of the Deccan Trap. Their distribution in India is described in detail with distribution maps and photographs and Table.

Boswellia serrata, *Garuga pinnata*, *Terminalia chebula*, *Terminalia arjuna*, *Terminalia bellerica*, *Terminalia crenulata*, *Terminalia paniculata*, *Anogeissus latifolia*, *Syzygium cuminii*, *Gymnosporia montana*, *Tectona grandis*.

Several genera which are endemic to India are reported in the Deccan Trap area e.g. *Erinocarpus*, *Butea*, *Wagatea*, *Lamprachenium*, *Caesulia*, *Glossocardia*, *Goniocaulon*, *Adenoon*, *Frerea*, etc.

Aeschynomene and *Biophytum* are the genera considered to be least represented in Asia—Australia regions. They are common in the Deccan Trap. Their distribution has been shown by map.

There is a large number of plants which are common in South Western India i.e. in the Western Ghats and Malabar. Their northern boundary lies within the Deccan Trap. They do not extend to Rajasthan, Kutch or Central India; e.g. some species of *Combretum*, *Syzygium*, *Osbeckia*, *Polyzygma*, *Anotis*, *Psychotria*, *Notoniana*, *Diploclisia*, *Ancistrocladus*, *Elaeocarpus*, *Geissaspis*, etc.

The distribution of these genera in India is shown by distribution maps or tables.

Several genera typical of Indo-Malayan flora are present e.g. *Hiptage*, *Elaeocarpus*, *Mussaenda*, *Ficus*, *Garcinia*, *Clematis*, *Aristolochia*, *Impatiens*, *Strobilanthes*, *Smilax*.

Several species common with mediterranean flora are found in this area e.g. *Chloris villosa*, *Heliotropium ovalifolium*, *Cenchrus ciliaris*.

7. G. S. PURI, S. K. JAIN and U. R. DESHPANDE (Poona) : *Some Aspects of the Distribution Patterns in Kutch Flora.*

The flora of Kutch has very interesting place in the vegetation of India because of the peculiar situation of this State. On its immediate west is Arabian sea, on north-west the Indus Delta, on north the dry arid zone of Rajasthan, on east the vast cultivated lands of Gujerat and on south the peninsula of Saurashtra.

There is very poor natural vegetation on the immediate east and south-east and the whole of Gujerat is under heavy cultivation. Further south-east is the vast Deccan Trap. There are a number of plants which are found in Indus Delta and/or Rajasthan and/or Sind and/or Saurashtra, but not reported so far in the Deccan Trap country within the districts of Ahmednagar, Poona, Thana, Sholapur and North Satara. Some of these, for example, are *Farselia jacquemontii*, *Cleome papillosa*, *Cleome stocksiana*, *Cleome burmanii*, *Polygala irregularis*, *Portulaca tuberosa*, *Tamarix troupii*, *Tamarix dioica*, *Bergia odorata*, *Pavonia glechomifolia*, *Pavonia arabica*, *Pavonia zeylanica*, *Grewia populifolia*, *Grewia villosa*, *Tribulus alatus*, *Sectzenia orientalis*, *Zygophyllum simplex*.

The Flora of Kutch is dominated by shrubs. The commonest shrubs are *Capparis decidua*, *Calotropis gigantea*, *Euphorbia nerifolia*, *Euphorbia tirucalli*, *Grewia tenax*,

Grewia villosa, *Cassia auriculata* etc. The distribution of these species in India is shown by distribution maps.

The distribution of commonest tree species such as *Salvadora persica*, *Tamarix dioica*, *Acacia arabica* is also shown by maps.

Some plants have been noted by us as new records for Kutch. It is interesting that most of these were reported earlier from Indus Delta and Sind. They have obviously travelled eastwards of recent.

More interesting species with regard to discontinuous distribution etc. are illustrated by drawings and photographs.

8. T. ANANDA RAO (Dehra Dun) : *Observations on the Flora of Bugyals (Alpine grassy meadows) of Martoli and Milam in Johar patti, Almora District, U.P.*

This paper describes the distribution pattern of Bugyal flora of Malla Johar patti extending from the Tibetan border down to the Goriganga valley as far as its junction with Ralam valley.

The flora is very distinct and the mountain slopes are covered with graceful herbs and stunted shrubs of different growth forms. The distribution pattern of Bugyal flora clearly indicates that edaphic and climatic factors play a very important part in the successive occurrence of stunted shrubs and carpets of graceful herbs in patches almost to the exclusion of other plants from early April to the end of October. The edaphic difference in the formation of different plant communities and undergrowths are studied with reference to *Betula* grooves and *Junipers* association of the Bugyal flora.

The Bugyal vegetation changes in accordance with the elevation and each species has its own range of toleration. In and about 5000 m. upto the snow-line the vegetation is scanty, more or less scattered and seldom do they appear in close association.

The importance of air currents and their influence on the plant distribution and life forms in the Himalayas at higher altitudes await careful investigation.

9. L. P. MALL (Sagar) : *Patterns of Forests on Soils of Basalt and Red Sandstone in Sagar.*

In Sagar which is situated in Madhya Pradesh at latitude 23°50'N and longitude 78°50'E, the terrain comprises of undulating hillocks and valleys. Basalt and Vindhyan sandstone are two main types of rock in the vicinity of Sagar. The natural vegetation on the soils of these rocks is of the following two types:—

(i) Grasslands which can be stated to be biotic climax, according to the school of poly-climax view. The common species are *Themeda caudata* Dur et Jack, *Apluda aristata* Linn., *Cymbopogon martini* Watson, *Heteropogon contortus* Beauv., *Setaria nervosum* Stapf., *Sorghum nilidum* Pers., *Ischaemum rugosum* Salisb., *Andropogon pumilus* Roxb., *Aristida cynantha*, *A. adscensionis* Linn., *Dichanthium annulatum* Stapf., *Chloris barbata* S.W. etc.

(ii) Woodlands. The forest is typical tropical mixed deciduous type. The species occurring on a typical sandstone and basalt soils near Sagar are more or less the same and none of them can be said to be exclusive to one type of the soil.

At Garhpara the forest growing on sandstone is poorer in species on account of probably the texture of the soil aided by severe anthropogenic interference. The common tree species are *Odina woderi* Roxb., *Terminalia tomentosa* W. & A. En., *Cassia fistula* L., *Ficus* sp., *Albizia procera* Benth., *Wrightia tinctoria* R. Br., *W. tomentosa* Roem., *Bauhinia* sp., *Stephegyne parviflora* Korth., *Lagerstroemia parviflora* Roxb., *Bridelia relusa* Spreng., *Holoptelia integrifolia* Planch., *Aegle marmelos* Correa, *Diospyros melanoxylon* Roxb., *Saccopetalum tomentosum* HK.,

Butca monosperma (Lamark) Taub., *Acacia catechu* Willd., *Terminalia glabra* W. & A., *Gardenia latifolia* Ait. etc. The shrub layer is occupied by *Helicteres isora* Linn., *Holarrhena antidysenterica* Wall., *Flacourtia ramontohi* L'Herit., *Carissa spinarum* A. DC., *Zizyphus aenopia* Mill, *Barleria prionitis* L. etc. The herb layer is represented by numerous grasses like *Oplismenus* sp., *Arthraxon lancifolius* Hockst., *Echinochloa colonum* Link., *Bothriochloa pertusa* (Willd) A. Camus, *Panicum javanicum* Poir, *Eleusine indica* Gaertn., *Dactyloctenium aegyptium* Beauv., *Heteropogon contortus* Beauv., etc., and herbs like *Cassia tora* L., *Cassia absus* Linn., *Corchorus* sp., *Achyranthes aspera* Linn., *Triumphetta neglecta* W. & A. Among climbers the common ones are *Vitis trifolia* L., *V. latifolia* Roxb., *Dioscorea bulbifera* L. etc. and *Ventilago inadaraspatana* Gaertn., a strong liana.

At Patharia the forest growing on basalt is richer in species which show better growth form. In this forest the human interference is comparatively less. All the species occurring at Garhpara are found here and a few more like *Tectona grandia* L., *Anogeissus latifolia* Wall, *Dalbergia paniculata* Roxb., *Eleodendron glaucum* Pers., *Schleichera oleosa* (Lour.) Mer., *Buchnanian lanzan* Sprang., *Ixora parviflora* Vahl., *Kydia calycina* Roxb., *Careya arhorea* Roxb., *Ougenia dalbergoides* Benth. etc. The shrub and herb storey is more or less similar. This richness of species may be due to soil with better texture and less of biotic interference. The chemical characteristics of soils of both forests is more or less the same.

10. S. C. PANDEYA (Jabalpur) : *Soil and Climatic Factors in Determining Distribution Pattern of Plants.*

An attempt is made to dilate upon the following broad principles in evaluating the distribution patterns of plants.

1. Soil factors—appear largely to determine only the local distribution of plants.
2. Climatic factors—are probably most potent to determine the distribution of large species of vegetation. Climatic factor is also responsible for bringing about some local soil variants. Further it has been discussed that possibly under similar climate soil tend to be similar irrespective of underlying rocks.

Local variants in soil are due mainly to relief which also changes the micro-climate. This largely accounts for the variations in local dominance of species and sometimes sudden change in flora. The point is illustrated with several data.

Sal studies in Madhya Pradesh have shown that, under a particular range, all the soils under Sal (derived from oldest to recent geological formations) tend to be similar. Thus geology does not appear to govern the distribution of plant.

From a study of distribution of Sal and *Anogeissus latifolia* it is noted that a species is distributed depending upon its climatic requirements. Thus Sal has only 2 zones of its distribution i.e. in sub Himalayan and Central India.

So far we have been supposing that soil is closely connected with the underlying rocks and that different rocks weather to give rise to different soils. This statement appears to be of doubtful value. It has been discussed that upto the stage of soil formation the parent material have a profound effect on the characters of soil. Once the soil is formed the maturation seems to be governed only by climate and vegetation. It appears that correct view for soil development would be to regard the parent material, soil forming factors (specially climate) and vegetation as one system. Here parent material probably offers only a seat in which the climo-vegetational activities prepare the soil.

11. R. MISRA and R. R. DAS (Varanasi) : *Distribution patterns of some rainy season annuals in North India.*

It appeared to us that the shallow rooted annuals growing in drained areas during the rainy season may be very much dependent upon the rainfall for that

period as they are free from the complications of the perennial life and the extremes of temperature and drought. Hence we have tried to determine the rainfall range-distribution of some rainy season annuals belonging to the more voluminous families like Rubiaceae, Compositae, Acanthaceae, Cyperaceae, and Graminae distributed in extra-Himalayan Northern India. Incidentally this region has a more or less uniform type of soil in the Indogangetic-Brahmaputra alluvium and from East to West presents a rainfall regime of 2000 mm. to 120 mm. during the months June-October. The larger families of the plants have been chosen not for any other reason than for their rich contents of annual species from among which a good rainy season flora could be found. Information regarding the geographical distribution of the plants has been collected from the flora of Hooker and other local floras. The rainfall data has been taken from the National Atlas of India. The maximum range was obtained for *Spermacoce hispida* Linn., *Pycnus nitens* Nees., *Eleusine indica* Gaertn., and *Sporobolus coromandelianus* (Rets.) Kunth. The species with narrowest range for 120-200 mm. only are *Hedyotis lineata* Roxb., *Oldenlandia trinervia* Rets., and *Andropogon pumilus* Roxb.

12. S. S. RAMAN (Varanasi) : *A study of biotic and edaphic factors in the distribution of grasses.*

Normal atmospheric precipitation and relative humidity afford a congenial environment for the best growth of grasses in Banaras district with soils formed on uplands, lowlands and Vindhyan plateau in south-east, lies in the chestnut brown region of international classification. Edaphic factor is a collective term for many of the soil properties which may control the vegetation. The ravages of human and animal populations and water erosion total the biotic factor operative against the vegetation on any piece of the landscape. Under a uniform climatic cover, the dual impact of biotic and edaphic factor on the herbaceous vegetation stimulates certain distribution patterns in the flora.

Dichanthium grassland type as noticed by the author is wide spread on the soil type III from the western uplands. Excessive grazing coupled with compactness of the soil and vehicular traffic play a decisive role to assort *Setaria-Cynodon*, *Eragrostis-Sporobolus*, *Bothriochloa* biotic sub-types out of the herbaceous vegetation sampled on the plains. *Dichanthium annulatum* assumes its dominance and permanence of the habitat over other grasses of the side, if protected from biotic factor, because of its deep rooted perennial bunch habit and high fertility of the sites evident from the physico-chemical analysis of the soil type III marked on the soil map of the district.

Hilly areas present altogether a different aspect of grassland cover where the soil runs off, and leaching acts adversely against *Desmostachya-Chrysopogon* association from Vindhyan uplands. Fertility of such grassland soil is very low coupled with high contents of magnesium and low water holding capacity. No weed competition is present for the grasses of the hills but the vegetal cover is open with small rock fragments. Grasses of the plains are under biotic stress while the hill grasses are subjected to edaphic degradation as the study reveals.

This ecological presentation supports the view point of Whyte (1957) that the variations in types of grassland produced in a locality are determined by the way these factors (biotic) operate in combination with other factors of the site.

13. V. N. KAUL (Varanasi) : *Distribution of Xanthium strumarium Linn. Complex in India.*

Studies have been made to explain wide geographico-ecological distribution of the species by means of its various forms developed in response to the environment. The environmental stress working within its genetical amplitude at different onto-

genic phases of the life cycle is met by the plastic species in a remarkable way. Ordinarily out of the two seeds in the fruit the lower one germinates at $>21^{\circ}\text{C}$, and the upper one at $>28^{\circ}\text{C}$, but if the testa is pinpricked or injured germination may set in at $17-18^{\circ}\text{C}$, thereby explaining the growth in areas where germination is delayed due to waterlogging upto mid or late winter, when the temperatures are not sufficiently high. Similarly seeds thrown into secondary dormancy due to prolonged soaking or anaerobic conditions, germinate promptly on injuring the testa. The seeds germinate in pure oxygen very quickly, but the germination is equally quick when the CO_2 concentration is comparatively twice or thrice of that of oxygen, and this phenomenon may explain the germination in such habitats where seeds get buried to considerable depth (1-18.5 cms.). The seeds germinate only when mature but injury to the testa brings about the germination of very young and immature seeds, collected only a few days after anthesis. The species has got the structure and anatomy of a land plant, but exhibits the root anatomy of a typical water plant, with well developed aerenchyma under water-logged conditions. Although the species showed different growth behaviour in the 30 different soil types collected from different parts of the country, yet, however, little the vegetative growth was, it was without exception, followed by successful ripening of viable seed.

The same was true of the plants which could not grow to a more than few cms. high due to the prolonged conditions of physiological drought. Generally the seeds ripen on the parent plant only, but those of the plants removed for eradication only after a few days after anthesis do not lag behind (though to a limited extent) in this respect: due to the quick mobilization of food materials from entire plant body to the developing embryos. The plant ordinarily completes its life cycle from high temperature regime to low temperature regime. It may, however, exhibit a number of forms with growth in an initial low temperature terminating into high temperature regime, and constant high or even in constantly low temperature regimes, provided the germination is delayed. The species has been found to behave as a short day one with a critical photoperiod of 13.5 hours, but in Varanasi we get a number of forms with critical photoperiods ranging right from 13.5 hours to continuous day light. The growth and occurrence of these forms in summer days when the day length exceeds the critical period would account for out of season individuals of the species.

14. P. S. RAMAKRISHNAN (Varanasi) : *Distribution of Euphorbia thymifolia Linn. in Relation to Soil Calcium.*

In *Euphorbia thymifolia* Linn. two interbreeding forms were observed in the field—(i) coppery red form having a coppery red tinge throughout the plant body and (ii) green form. Upon hybridisation the F_2 generation segregates in the ratio of 15:1, in which 15 represents four different grades of red colour in the plant and 1 being the pure green form. Thus altogether 5 forms have been recognised—

RR RR Rr Rr and rr
RR Rr rR rr rr . These are found in nature also.

It is found that the first two forms mentioned above can grow in calcium rich soil as well as in calcium poor soils while the latter 3 forms can thrive only in non-calcareous soil. Thus, in nature all the 5 forms can be found growing side by side only in calcium poor soils.

The calcifuges— $\begin{matrix} \text{Rr} & \text{Rr} & \text{and} & \text{rr} \\ \text{rR} & \text{rr} & & \text{rr} \end{matrix}$ are very sensitive to calcium in regard to their germination and seedling growth while the other two— $\begin{matrix} \text{RR} & \text{RR} \\ \text{RR} & \text{rR} \end{matrix}$ can thrive irrespective of soil calcium. Moreover, the absence of calcifuge forms of *E. thymifolia* in calcareous soils is accounted for as due to severe root competition

between better equipped $\frac{RR}{RR}$ and $\frac{RR}{rR}$. It has been found that calcifuge habit of plants in tropics is not necessarily accompanied by acidity of the substratum.

15. S. R. JOSHI (Jabalpur) : *Distribution of Anogeissus latifolia in Madhya Pradesh.*

Phytosociological studies of some Madhya Pradesh forests have revealed that *Anogeissus latifolia* is distributed in all 3 types of M.P. forests. Growth, however is best in miscellaneous forests (undisturbed) followed by Teak and Sal forests. The species, however, never grows in aggregates. It is always hypodispersed. Its low sociability is probably due to its low percentage of germination. The study has further revealed that this species is probably a transitional one. On one hand it appears to take from such low species as *Carissa spinarum*, *Celastrus montana* and *Zizyphus* spp. and on the other hand it probably merges into dense climatic climax forests of Teak and Sal.

All attempts to correlate its distribution with geology have failed. Similarly under certain limits *Anogeissus latifolia* is quite plastic to the conditions of soil. Only the climatic factor may account for the pattern of its distribution. It grows best in the climates of miscellaneous forests of M.P. It, however, avoids too dry, too moist, too hot and too cold regions. Within this limit the tree successfully competes and establishes itself in 3 types of forests.

It is thought that phytosociological studies give the clear picture of the distribution of any species.

16. N. K. JAIN (Jabalpur) : *Factors Effecting Pattern of Sal (Shorea robusta Gaertn.) Distribution in Madhya Pradesh.*

The important Sal bearing divisions of Madhya Pradesh are Bastar, Raipur, Mandla, Bilaspur and Balaghat. These forests were studied phytosociologically. These results have made us to believe that detailed phytosociological characters are the best to judge the pattern of distribution of a species.

It is noted that any attempt to correlate geological formations and the type of Sal forests growing upon them will not lead to any conclusion. The soils from Sal forests are characterized by pH in the vicinity of 6 or little less, low exchangeable calcium and about 50 to 60 per cent sand fraction. Quite remarkably, these characters are so maintained in all the good quality Sal irrespective of geological formations. This may conclusively throw light on the assumption that Sal bearing Soil's composition is largely as a result of Sal itself under the existing climate. Observations on the climate of Sal and non Sal areas would suggest the possibility that probably the distribution of Sal in this state and elsewhere may be largely governed by the climatic factors in which temperature, rainfall and humidity are master factors.

In the end I would like to put before the house that on the basis of our studies on the ecology of Sal, we are driven to believe that Sal distribution is probably governed by the climate to a large extent.

17. R. S. CHOPRA :

(1) Is the region, where polyploidy in *Rhododendron* is highest, the meeting ground of the different stocks?

(2) Sikkim appears to be the converging of various tracts followed by the plants in the . Should we regard Sikkim as a primary or a secondary centre of origin?

18. ROLLA SESHAGIRI RAO:

It would be interesting to know whether the species in Sikkim and NEFA which are more common in their specific characters show so much variation in chromosome numbers as hexaploids and dodecaploids.

II. TISSUE AND ORGAN CULTURE

Chairman: DR. R. MISRA, Banaras.

1. L. F. RANDOLPH (Cornell, U.S.A.): *Advances in Tissue Culture Research.*

The culture of cells, tissues and organs in sterile nutrient media is presently contributing to the solution of basic problems in physiology, biochemistry, morphology, cyto-genetics and allied fields. Such cultures provide a means of studying problems of growth and of interrelations of cells and tissues to the organism under rigidly controlled conditions for prolonged periods of time, and are being utilised in new lines of research by embryologists, horticulturists and plant breeders.

Beginning with the use of sterile techniques for the *in vitro* culture of plant embryos about 50 years ago, methods have been perfected for the sterile culture of stem and root tips, parenchyma tissue, cambium, plant tumors, ovaries, ovules and various other tissues and organs. The demonstration by Gautheret and White that by giving adequate attention to their nutritional requirements tissues could be cultured indefinitely, established the use of the new technique as a valuable tool in biological research.

In embryo culture experiments the attempts of Blakeslee, Van Overbeek and others to obtain normal growth of successively younger embryos, with controlled parthenogenesis as the ultimate objective, were only partly successful; but real progress in this direction has been achieved recently by culturing entire ovules, ovaries and inflorescences at the time of fertilisation, especially in Professor Maheshwari's laboratory at the University.

Significant advances in cytogenetics and plant breeding are being achieved by using *in vitro* culture techniques to obtain hybrids from wide crosses otherwise impossible. First demonstrated for *Linum* hybrids by Laibach in 1925, many additional examples can now be cited, including my own tripsacummaize hybrids obtained in studies of the evolutionary history of maize.

At the present time biological research offers unusual opportunities in many lines of investigation but none is more promising than tissue and organ culture. Numerous culture media, with or without minor elements and special growth substances, are now available from which to select the most suitable for a particular experiment. And as more and more information becomes available concerning the growth requirements of living systems, results of still greater significance may be expected from tissue culture research.

2. B. M. JOSHI (Delhi): *Some Aspects of 'in vitro' Culture of Tissues and Organs.*

The application of tissue culture techniques has greatly aided our understanding of factors underlying growth and development in vascular plants. Whereas we are somewhat familiar with the culture of excised cambium, roots, shoot apices, pollen, ovary and embryo, the culture of anthers, ovules, endosperm, and single cells is comparatively a new field. Semi-solid and liquid media have been used with alterations in the nature and concentration of the carbohydrate, and inorganic and vitamin constituents of the basic medium. The latter has been supplemented by the additions of amino acids, auxine and a wide range of complex substances like malt extract, yeast extract, casein hydrolysate, endosperm extracts, bacteria free milk, peat extract etc.

I shall confine my attention to some aspects of artificial culture of root, anther, pollen, ovule and single cells.

Root culture—The continuous culture of excised roots of cereals usually shows diminished growth with every passage (Street, 1957). Roberts and Street (1955) succeeded in obtaining undiminished growth of Petkus II rye on modified White's medium by the addition of B.D.H. peptone or Difco yeast extract. A clone was established as sector cultures and maintained without diminution of growth rate through 38 passages of 14 days duration. It was discovered that eighty per cent of the growth stimulation was due to the L-tryptophane content of yeast extract. Tryptophane added aseptically to the previously autoclaved medium did not stimulate growth indicating that it was activated during autoclaving. That this is not due to the formation of IAA, was confirmed by chromatography of the activated tryptophane. In spite of the success attained with rye, the general problem of continuous culture of cereal roots, however, remains unsolved.

Anther culture—In recent years, excised anthers with pollen mother cells at the pachytene or diplotene-diakinesis (Gregory, 1940; Taylor, 1950; Sparrow *et al.*, 1955; Linskens, 1956), or even at leptotene (Vasil, 1957, 1958) have been satisfactorily cultured but the development generally stops at the tetrad stage. In the case of *Allium cepa*, Vasil (unpublished) tried liquid as well as semi-solid White's medium with various supplements but failed to stimulate growth beyond the 1-celled microspore stage. This inhibition is an unsolved problem, but it is just likely that the growth of anther depends on any specific growth factor about which we have no knowledge.

Pollen culture—The *in vitro* and the *in vivo* germination of pollen grains is more or less similar except for the production of shorter tubes in culture. Among the seed plants, only a single case of *Ginkgo biloba* is known where the pollen, when cultured on White's medium with autoclaved coconut milk, yeast extract or aqueous extract of pollen, occasionally produced a parenchymatous undifferentiated tissue. Most of the tissue was derived from the divisions of the tube cell, and developed more frequently when pollen was cultured in large masses (Tulecke, 1957). Even with the use of kinetin, which promotes cell division, such a behaviour has not been noticed in any other plant.

Ovule culture—As a rule, embryos excised at the globular stage or earlier do not grow in culture. However, this difficulty is overcome as soon as the cotyledonary primordia have differentiated. While we must await further researches in this field, an indirect method is now available. At least in some cases like *Papaver* and *Argemone*, the excised ovules can be readily cultured from the zygote or two-celled proembryo stage onwards (N. Maheshwari, 1958; N. Maheshwari and Lal, unpublished). The ideal condition would be to dissect out the fertilized embryo sac and culture it like the pollen grains. No such technique has so far been evolved but there seems to be no reason why it should not be possible in the near future. The success will lead to a better understanding of nutritional and related problems.

Single cell culture—During the past decade, the cultivation of single cells has been the aim of several investigators but not much success has been achieved. Gautheret (1955), Nobecourt (1955), Reinert (1956), Sachar and Iyer (1958) and others observed the dissolution of the various tissue cultures into cell groups and sometimes into separate cells. Nickell (1956) was able to maintain single cell cultures of the hypocotyl tissue of *Phaseolus vulgaris* in liquid medium under submerged conditions. Torrey (1957) cultivated cells isolated from a pea root callus tissue on an agar drops of nutrient medium if the latter had been previously inoculated with the callus tissue to serve as a 'nurse'. In both cases the cells showed normal growth and division. Single cell cultures can be used for the study of the totipotency of cells, and for similar studies as have been possible with microorganisms.

The cultures of anther, ovary, ovule and embryo show satisfactory growth at a light intensity of 25-50 foot candles (diffuse sun light), and a temperature of 28°C with a relative humidity of 50 per cent. Minor variations in these conditions do not alter the pattern of growth.

The major problems facing the tissue culturist require the estimation of minimal requirements at various stages of growth and development. Also, it is essential to have a better understanding of metabolic processes which occur *in vivo*. Therefore, further progress in this field is closely linked with the advancements in the field of physiology and biochemistry.

3. S. N. UPADHYAYA (Varanasi) : *Culturing of Some Oedogoniaceae.*

Some members of the family Oedogoniaceae were taken up for studying their behaviour in cultures under laboratory condition. The forms chosen were *Oedocladium operculatum* Tiff., *Bulbochaete varians* Wittrock, *Oedogonium lautumnarium* Wittrock forma *tenuis* Singh, *O. tapeinosporum* Wittrock forma *minor* Singh and *Oedogonium* species (undetermined). The behaviour of *Oedocladium* which had not been studied in cultures, has been described in detail. Zoospores were used for raising the cultures, because in most of their ready availability. The material collected from nature and from cultures was given various types of treatment, both physical and chemical, in order to liberate swimmers. As the usual methods recommended for the formation of zoospores failed in *Oedocladium*, other methods were also used viz. nitrogen starvation alone or accompanied with darkening, but the alga failed to liberate zoospores. However, these methods were successful in *Bulbochaete varians* and the three species of *Oedogonium*. The plants under treatment were studied in hanging drop cultures. As the behaviour of *Oedocladium* was different, its 'clone' culture was raised from special apical cells.

Inorganic media were not suitable for *Oedocladium* without the addition of organic extracts. The actual nutritional requirements of the organism were found by replacement technique. Organic compounds with or without nitrogen were used as growth promoters. The effect of pH was studied critically and the optimum pH in cultures was found to be 7.8. The effect of chelating agents and trace elements was studied and the best chelating agent in this case was Fe EDTA. The rate of growth was studied and the growth—curve of this species of *Oedocladium* showed a similarity with that described by Fogg for *Anabaena cylindrica* Lemm.

4. G. C. MITRA (Delhi) : *Morphogenesis in Mosses in Sterile Culture.*

The ontogenetic pattern of the protonema of *Pohlia nutans* was little affected by the several physiologically active substances tested (IAA, IAN, NAA, kinetin and gibberellic acid), except NAA.

The auxins tested had no specific effect on bud formation apart from an inhibitory effect at higher concentrations, but the results with kinetin and gibberellic acid were of considerable interest. Both substances led to a great increase in the number of buds formed in light, and furthermore the buds were formed at a very early stage in the development of the protonema. This indicated that not only did these chemicals stimulate budding but they also markedly reduced the period of growth of the protonema prior to budding. It was also noted that in these cultures a large number of buds appeared when little growth of the protonema had taken place, while buds appeared in the control cultures only when the diameter of the protonemal mass was approximately three times that of the cultures containing kinetin and gibberellic acid. These observations are contrary to the findings of Gorton and Eakin (1957) who inferred that the protonema must be of the proper "age" to bud, an "age" which is independent of any chemical treatment. The

present study also does not provide any evidence for the concept of a growth-inhibitor as mentioned in the mechanism for bud formation suggested by them in *Tortella caespitosa*.

It is of interest to note that two unrelated chemicals produced almost similar effects on bud formation and development in *Pohlia nutans*. Furthermore an elongating effect of gibberellic acid was not noticed in any of its concentrations used.

Work with other plants has suggested that kinetin and gibberellic acid can substitute for light, at least in part, in the production of a number of morphogenetic effects. Whether or not kinetin or gibberellic acid will induce the formation of buds in darkness, remains to be seen.

Kinetin and gibberellic acid affected the subsequent development of the buds resulting in various abnormalities.

0.1 mg./l. IAA in combination with 0.1 mg./l. kinetin, produced more normal leafy plants than either 0.1 mg./l. kinetin or 0.1 mg./l. IAA alone, but IAA could not counteract the adverse effect of higher concentrations of kinetin.

5. B. BALDEV (Delhi): *In Vitro Culture of Shoot Apices of Cuscuta reflexa Roxb.*

Loo (1946) for the first time cultured the shoot apices of *Cuscuta campestris* and besides the normal vegetative growth was able to get a few flowers. Recently, Bertossi (1956) induced flowering provided the shoot apices along with the haustoria dissected out from the host tissue were inoculated on the medium.

The present work on *C. reflexa* was undertaken with a view to obtaining vegetative growth as well as flowering under controlled conditions of nutrition, light and temperature. Normally the plant produces flowers and fruits from November to January. Then it survives for several months in a vegetative condition in relatively cool and shady localities. The material for inoculation was collected during March—May, 1958.

Stem apices (0.5—1.0 cm.) were inoculated on Nitsch's basic medium with 5 per cent sucrose and IAA 1 mg./l. When the cultures were kept in diffused light at 30°C or higher temperatures (39°C), they did not show much activity and dried up within 3—4 weeks. If the temperature was maintained at 25°C, there was profuse vegetative growth for 6—7 weeks, and the stem developed chlorophyll. Later, the branches began drying up from the base upwards. Vegetative growth was more or less similar in darkness and in light except that in the former case the chlorophyll failed to develop. Further, flowering and fruiting occurred only if the cultures were kept in darkness. The pollen grains obtained from *in vitro* flowers were viable and germinated satisfactorily.

When the basic medium was supplemented with yeast extract (0.5 per cent), the epidermal cells in contact with the medium elongated irregularly and penetrated the medium. They were rich in cytoplasm and simulated haustorial structures. Auto-parasitism has also been observed *in vitro*. Cultures of stem tip can be continuously subcultured.

6. I. K. VASIL and NANDA BOSE (Delhi): *Cultivation of Excised Anthers and Pollen Grains.*

The anthers are an integral part of the flower and play an important role in the life history of angiosperms. So far very little is understood about their nutritional requirements and physiology. In this brief communication, the results of experiments on the cultivation of excised anthers of *Rhoco discolor*, and the effect of temperature and pH on the germination of pollen grains of some crop plants are presented.

Anther culture—*In vivo*, within one day (ca 24 hours), anthers of *Rhoco discolor* with microspore mother cells at leptotene showed meiosis I (metaphase to anaphase I) or dyads, while after two days only tetrads were observed. Anthers excised at various stages of development and cultured in double distilled water or agar did not show any growth. In White's medium (WM, see Vasil, 1957), some of the mother cells had formed dyads but hereafter there was no further development.

Considerable improvement in the growth of anthers excised at leptotene zygotene or diplotene-diakinesis was observed when the basic medium (WM) was supplemented with any one of the following chemicals: phenylacetic acid (5 ppm), naphthoxyacetic acid (5 ppm), coconut milk (25 per cent), kinetin (0.1 mg/l) and gibberellic acid (1, 5 and 10 mg/l). The optimum growth occurred with the addition of gibberellic acid (5 mg/l). Only 4 per cent of the mother cells remained undeveloped, while 28 per cent formed dyads and 68 per cent tetrads. Besides, there was favourable development when coconut milk or naphthoxyacetic acid was added to the medium.

Pollen culture—By the usual hanging drop technique, the pollen grains of *Arachis hypogaea* (TMV. 4), *Crotalaria juncea*, *Cucumis melo* var. *utilissimus*, *Dolichos lablab* and *Pisum sativum* were cultured in sucrose-boric acid media at different temperatures (5° to 45° C). In all the plants studied, the optimum percentage of germination and tube length were obtained between 25° and 30° C. There was inhibition of germination as well as of tube growth at temperatures beyond 30°C. Practically no germination occurred at 5° C and above 40° C. At higher temperatures, marked bloating and swelling of the tips of pollen tubes and bursting was noticed. Irrespective of the temperature, the growth curve of the tube remained typically sigmoid. The Q_{10} is roughly 2.

The effect of pH was studied on the pollen grains of *Cucumis melo* var. *utilissimus* and *Arachis hypogaea* (TMV. 4). Contrary to the observations of the earlier workers (Berg, 1930; Sisa, 1930), the percentage of germination and the length of tubes remained almost unaltered in a medium the pH of which was varied from 3.5 to 9.0 using N/100 HCl or N/100 NaOH. When the pH was regulated by buffer salts, there were marked fluctuations in germination and tube lengths. This behaviour could be due to the effect of cations and anions rather than pH.

It would appear that the percentage of germination and the length of tubes are in no way affected by the change of pH of the medium. Further, the pH of the medium remained constant even after the pollen tubes had grown in it for 24 hours. Probably the metabolism of the tubes does not appreciably alter the pH of the medium.

7. NIRMALA MAHESHWARI, MANOHAR LAL and MANJU KAPOOR (Delhi): *Artificial culture of Excised Ovules.*

A long standing problem in biological sciences is the activation of the unfertilized egg. It was felt that the artificial culture of excised ovules should offer an approach to the problem of parthenogenesis. However, as a prerequisite, a sound background of conditions necessary for cultivating fertilized ovules needs to be built up. The present work on *Papaver somniferum*, *Argemone mexicana* and *Cooperia pedunculata* is an attempt to fulfil this requirement.

The ovules sown in the nutrient medium at various stages of development, ranging from the unpollinated to the almost mature embryo stage. Those of *Papaver* could be reared from the zygote to mature embryo stage in the Nitsch basic medium (NBV) itself. Similarly, in *Argemone* they do grow up to maturity but the development is attended by many abnormalities. In *Cooperia*, when the ovules are inoculated at the zygote stage with the primary endosperm nucleus, the

embryo develops only up to the globular stage. However, if planted at the globular stage, the ovules mature as usual and produce healthy seedlings.

Among various chemicals, the influence of kinetin, gibberellic acid, IAA, 2, 4-D, casein hydrolysate and yeast extract has been investigated. In NBV supplemented with kinetin and gibberellic acid, unpollinated ovules of *Cooperia* mature into normal black seeds as in nature but are abortive. In *Papaver* also only the seed coat of unfertilized ovules is stimulated in media supplemented with different concentrations of kinetin. By far, the best results have been obtained with casein hydrolysate (Difco). The zygote, in *Argemone*, which does not divide in nature for as many as 10 days after pollination, can be activated to divide without any rest period if the freshly fertilized ovules are grown in MBV supplemented with casein hydrolysate. Apart from the basic medium, the best growth of ovules of *Papaver* has also been obtained with casein hydrolysate.

The stage of development of the embryo and the endosperm strongly conditions the reaction of the ovules to various media. For instance, while exogenous auxin is stimulatory for ovules of *Papaver* excised 4 days after pollination, the same concentration markedly inhibits the growth of 6-day old ovules. Similarly, the best response to the addition of vitamins is elicited from 6 day old ovules, while 8, 12 and 20 day ovules are somewhat inhibited in the presence of vitamins.

Under *in vitro* conditions as compared to the embryo, the endosperm, seed-coat, and nucellus are subject to less modification. Unlike *Opuntia* (Sachar & Iyer, 1958), the placental tissue of *Papaver*, *Argemone* and *Cooperia* does not show any tendency to proliferate.

8. S. NARAYANASWAMI and N. S. RANGA SWAMY (Delhi) : *Plant Embryo growth in vitro*.

In view of the paucity of data on embryo growth *in vitro*, a series of experiments were undertaken with the embryos of millets and oranges. Modified White's solution was used as the control medium throughout. Effects of varying concentrations of adenine, guanine, kinetin, gibberellic acid, casein hydrolysate, maleic hydrazide, coconut milk, tomato juice etc. have been studied.

In cultures of intact embryos of *Pennisetum*, growth was normal on the control medium. With the addition of adenine, as low as 1 ppm, the scutellum developed into a tumoroid mass and the embryonal axis was inhibited. Addition of exogenous IAA (2 ppm) along with adenine accentuated the scutellar growth resulting in lobulate scutelli.

Similar results were obtained with the purine derivative, guanine. Anatomical studies have indicated that adenine and guanine are specific for scutellar growth, as far as *Pennisetum* embryos are concerned, the homology of a scutellum being that of a leaf.

With different supplements in the culture media, the ontogenetic pattern of growth varied with the age and morphological differentiation of the embryo. The younger the embryo, the more abnormal was its behaviour.

Recognising the importance of adventive embryo in plant improvement, it was thought worthwhile to investigate if it would be possible to culture excised pro-embryos to maturity and if the proliferative capacity of the nucellar tissue, which is the source of embryos in oranges and lemons, could be maintained in culture. *Citrus microcarpa* was chosen for experimentation.

On modified White's medium (WM) there was no growth except for a slight swelling of the proembryos. Addition of casein hydrolysate (CH; 400 ppm) proved favourable and differentiation of the embryos to heart-shaped, torpedo and fully mature stages proceeded normally. This is one of the few instances where pro-embryos have been reared *in vitro* to maturity.

When nucelli (or portions thereof), in which adventive embryos had begun to differentiate were cultured on WM alone, no growth occurred. The addition of CH (400 ppm) resulted in the proliferation of the nucellar tissue into tissue masses which we have designated as 'pseudobulbils'.

The pseudobulbils were capable of continuous subculturing and the parent culture could also be maintained over a period of two years. In two-month old cultures, seedlings bearing normal leaves were produced.

The investigations are of intrinsic value to the particular problem of embryo nutrition, the most provocative results being the continued growth of scutellum (of *Pennisetum*) and nucellus (of *Citrus*) *in vitro*.

9. K. SULBHA and R. D. IYER (New Delhi): *Embryo Culture Studies in Jute and Tomato*.

A unit for Embryo Culture has recently been established at the I.A.R.I., New Delhi, to investigate the causes for the failure of seed setting in some inter-specific crosses of interest to the plant breeder and to apply the embryo culture technique to overcome the sterility caused by a premature abortion of the embryo. Under this project, studies were taken up in the cross *Corchorus olitorius* × *C. capsularis* and *Lycopersicon esculentum* × *L. peruvianum* and *L. glandulosum*. As a preliminary step, work was undertaken on the standardisation of media for culturing young embryos of jute and tomato and the results are presented in this paper.

Jute :

Heart-shaped embryos of *Corchorus olitorius* L. were cultured in White's basic medium. Addition of 0.1% yeast extract proved beneficial for the growth of the embryos. A further improvement was observed by the addition of 5% Seitz-filtered malt extract to White's+Yeast extract medium. The medium containing White's+Yeast extract 0.1%+Indole-acetic acid 0.1 p.p.m.+Gibberellic acid 1 p.p.m. gave the best results.

Tomato :

Young embryos of *Lycopersicon esculentum* var *sioux* were inoculated in Nitsch's medium+vitamins as suggested by White (1943) in combination with various concentrations of gibberellic acid, indole-acetic acid and casein hydrolysate. Embryos (2 mm. in size at the time of inoculation) were cultured in the following media (i) Nitsch's+Vitamins (control), (ii) Nitsch's+Vitamins+IAA (0.1 p.p.m.), (iii) Nitsch's+Vitamins+gibberellic acid (1 p.p.m.), (iv) Nitsch's+Vitamins+IAA (0.1 p.p.m.)+gibberellic acid (1 p.p.m.) and (v) Nitsch's+Vitamins+IAA (0.1 p.p.m.)+gibberellic acid (1 p.p.m.)+Casein hydrolysate (200 p.p.m.). It was observed that the embryos grow better when IAA or gibberellic acid was added to the control but the best growth was recorded in the medium which contained both IAA and gibberellic acid. This supports the observations of several workers that there is some sort of synergism in the action of the two chemicals. Addition of casein hydrolysate (200 p.p.m.), however, resulted in a deviation from the normal growth pattern and the young seedlings invariably showed a swelling in the hypocotyl region and remained stunted in growth.

Using White's basic medium as control for the culture of tomato embryos, it was found that White's+0.5 p.p.m. IAA showed excellent shoot growth, about three to three-and-a-half times that found in the control, but the root growth was not favoured.

The effect of different antibiotics such as Isonicotinic acid hydrazide, Streptomycin, Chloromycetin, Terramycin, Penicillin and Sulphonamide on the growth of immature and mature tomato embryos has also been studied.

10. R. C. SACHAR and R. N. CHOPRA (Delhi) : *Artificial Culture of Fruits.*

The *in vitro* culture of fruits aims at the determining the optimum requirements for fruit setting and development under more controlled conditions than is ordinarily possible with intact fruits (*see* LaRue, 1942; Nitsch, 1951, 1952; Jansen & Bonner, 1949; Anantaswamy Rau, 1956).

Studies on these lines are in progress in this laboratory, and successful *in vitro* culture of pollinated ovaries has been secured in *Linaria* (Sachar & Baldev, 1958), *Iberis* (Maheshwari & Lal, 1958), *Tropaeolum* (Sachar & Kanta, 1958), *Cooperia* (Sachar & Kapur, 1958), *Althaea* (Chopra, 1958), *Ranunculus*, *Nigella* (Sachar, unpublished), *Allium* (Johri & Baldev, unpublished), *Barbarea* (Baldev, unpublished), *Aerva* (Prem Murgai, unpublished), *Ranunculus* and *Raphanus* (Johri, unpublished),

The pattern of fruit growth remains essentially unaltered. In general, the *in vitro* fruits were smaller than the *in vivo* ones, although natural-sized fruits have been obtained in *Ranunculus*, *Iberis* and *Althaea*.

The pollinated ovaries could usually be made to grow on a basic medium. This was not true of unpollinated ovaries, which required an additional source of auxin. The ovaries of *Althaea* produced parthenocarpic fruits in cultures, whereas those of *Tropaeolum* and *Linaria* failed to do so.

In the pollinated ovaries of *Cooperia*, *Ranunculus*, *Althaea* and *Allium* the fruits mature and the seeds start germinating *in situ*. While this was possible in *Cooperia*, *Althaea* and *Allium* in the basic medium, in *Ranunculus*, casein hydrolysate (500-1000 ppm) was essential for the formation of seedlings. Fully differentiated embryos of normal size were produced in *Linaria* and *Iberis*, but in *Althaea* and *Tropaeolum* the size was mostly smaller than *in vivo*.

While the ovaries are maintained in culture, the pedicels often swell or callus at the cut end often followed by rooting.

So far we have discussed about plants in which pollination and fertilization are essential for normal seed and fruit setting. Recently, some experiments have been carried out on *Aerva*, which is parthenogenetic. When ovaries were cultured, the ovary wall swelled but the seeds were abortive. However, if yeast extract was added to the medium the seeds contained normal embryos.

Briefly then, it may be said that the study of test tube fruits opens a new channel for solving the problems of fruit and seed physiology.

11. B. SEN and GYANENDRA VERMA (Almora) : *Cultivation of Mustard Embryo and Seedling Fragments.*

In his "A Handbook of Plant Tissue Culture" (1943) and "The Cultivation of Animal and Plant Cells" (1954), Dr. Philip R. White, one of the pioneers in this field, gives the history, development and detailed technique for plant tissue culture. Since 1949, tissue culture technique has been used in the Vivekananda Laboratory, Almora, for raising complete flowering plants from embryos, and fragments of embryos and seedlings of both control and vernalised seeds of mustard T. 102. It has been shown in earlier contributions from this Laboratory (1947) that the changes induced in the seeds during the process of vernalisation are confined to the embryos, for plants raised from embryo isolated from dried unsplit vernalised seeds of mustard flowered significantly earlier than similar plants from control embryos. The purpose of these experiments has been to locate the region in the embryo, where the necessary physiochemical changes are induced during the process of chilling.

Fragments of embryos isolated from control and vernalised seeds of mustard T. 102 and fragments of seedling of control and vernalised seeds having similar hypocotyl lengths have been used. These were first cultivated in petri dishes

containing glass distilled water, different single salt solutions and different nutrient solutions. When the roots and the first leaves emerge from the fragments they are transplanted carefully in pots containing sterilised soil. For irrigating the pots they are placed in a water trough and kept covered within a thin plastic sheet in diffused daylight in a glass house till the fragments get well established. As is to be expected, plants raised from tissue fragments were diminutive in size and flowered at lower leaf number compared to plants raised from seeds.

From the results of experiments so far carried out it has been found that : (i) even in glass distilled water tissue fragments would exhibit growth elongation up to nearly 2 weeks, (ii) apical meristem cannot be regenerated, i.e., fragments without apical meristematic tissue will not develop into complete plants, (iii) complete plants can easily be raised from apical fragments with or without cotyledons having only 1 to 2 mm. of hypocotyl tissue, (iv) roots emerge earlier in seedling fragments with cotyledons, (v) roots emerge earlier in embryo and seedling fragments from vernalised seeds, (vi) cultivated in single salt solutions, 20 ppm. boron (as boric acid) induces early emergence of leaf and root in seedling fragments as also maximum growth elongation of the attached hypocotyl, (vii) calcium (as nitrate) 20 ppm. and manganese (as sulphate) 1 ppm. stimulate early root formation, (viii) zinc (as sulphate) 1 ppm. stimulates early initiation of leaf and finally (ix) plants raised from fragments of embryos and seedlings from vernalised seeds flower significantly earlier than plants raised from corresponding fragments from unvernalsed seeds showing that the physiochemical changes induced during the process of vernalisation are confined to the apical meristematic tissue. This technique is being used for studying the effects of different growth substances and plant extracts.

III. CARBOHYDRATE METABOLISM

Chairman : DR. R. MISRA, Banaras.

1. T. S. SADASIVAN (Madras) : *Carbohydrate and obligate parasitism.*

Among the many obligate parasites of fungal origin, the rust infected plant has been studied most from the point of host physiology. The first discernible effects on normal physiological functions of the rusted plants are increased respiration and reduced photosynthesis over the healthy plants and a reduction in the photosynthetic tissues of the lamina. There is distinct disturbance in the translocation of carbohydrate. Increased amylase and catalase activities have been noticed. In the grain there is decreased carbohydrate and an increased protein content. Dark treatment of inoculated plants in the first few days following infection results in intense rust development, whereas retarding photosynthetic rate after establishment of infection inhibits rust infection. Increased plant growth brought about by increased CO_2 in the atmosphere i.e., increased metabolic activity increases susceptibility to rust.

Turning our attention to another group of obligate plant pathogens, the virus, increased light intensity generally increases severity of symptoms in stable viruses causing mosaic diseases and is attributable to accumulation of carbohydrates in leaves. Unstable viruses seem to be inactivated by some photochemical reaction prior to multiplying in the host. Dark treatment for plants immediately following inoculation with stable viruses increases lesion production because of depletion of some fraction(s) of photosynthates that may accumulate in leaf cells and interfere with virus establishment. Like in the case of rust, there is increased respiration in the early stages of virus infection, reduced photosynthesis, increased enzymatic activity and retarded cell permeability. Carbohydrate accumulation and sluggish translocation with possible loss in diastatic activity is the general rule. Histological examination of laminae in many cases shows retarded chloroplast deve-

lopment in virus infected plants. Virus photoreactivation *in vivo* has been reported recently after the virus particles were subjected to ultraviolet irradiation prior to inoculation of leaf tissues. Photoreactivation is, of course, known among fungal spores, bacteria and bacterial viruses.

Virus nucleic acids have considerable quantities of carbohydrate where the sugar is a ribose. Much speculative thinking has gone into the origin of these virus nucleoprotein molecules where the ribose nucleic acid plays a prominent role in the infectivity of the virus protein. The main problem in this field is the study of origin of intermediary metabolites and the fate of polymers. It is generally believed that the host cell supplies energy substances essential for polymer synthesis and that plant viruses do not appear to be capable of donating energy metabolites for this polymer synthesis.

Recent work in this field of virus metabolism has been one of intensive study of virus inhibitors *in vivo*. A glycoprotein from *Phytolacca esculenta*, a polysaccharide from the fungus *Trichothecium roseum* and purine analogues such as thiouracil have been shown to block some components on the virus particles and prevent them from combining with essential host cell receptors. Much work can be done in this fascinating field and one can warmly commend this line for active consideration in our laboratories.

2. C. V. SUBRAMANIAN (Madras) : *Carbohydrate and the Facultative Parasite.*

The facultative parasite, in contrast to the obligate parasite, has the ability to live and complete its life cycle apart from a living host and, because of this ability, it has a dual mode of life, viz., (i) as a saprophyte, and (ii) as a pathogen. For most facultative parasites, therefore, there is also an alternation of a saprophytic phase with a pathogenic one, and in each of these distinct phases, carbohydrate as a substrate for growth and activity is important and essential. However, the pathogenic phase alone is being considered here in detail.

In many diseases in which necrosis is the feature, enzymes are involved and those of the pectolytic type are very common. Depending on the nature of the host substrate, and also on the nature of the pathogen, different enzymes come into play in the breaking up of the host tissues. On the basis of this, different types of rots may be distinguished.

In many diseases in which toxins are implicated in the disease syndrome, the carbohydrate of the host forms, perhaps, the most essential and important substrate for production of toxins, although other host components such as nitrogen, heavy metals, etc. are also necessary. The relation of carbohydrate substrate to pathogenesis in tomato wilt and cotton wilt with particular reference to lycopersamin, fusaric acid and formation of vessel-occluding substances is discussed. Chelation of microbial metabolites with heavy metals such as iron is accepted as a common *in vivo* phenomenon. Such chelation would starve host plants of their essential heavy metals which, in turn, would have a significant effect on the synthesis of chlorophyll in plants and also on photosynthesis directly or indirectly. Microbial toxins inducing foliage toxicity, are synthesized by pathogens from host substrates including carbohydrates; these toxins usually lead to derangement in photosynthesis. They cause local lesions and reduce the effective photosynthesis area of the leaf.

The behaviour of some wilt-inducing facultative parasites is such that even non-specific glucosans and related substances may be responsible for mechanical wilting.

Carbohydrates are, therefore, vitally important both as a substrate for pathogenic fungi *in vivo* and also as bases of host-pathogen interaction in pathogenesis in the

case of vascular wilts. They are also important substrates for *in vivo* pathogen-host interaction in other diseases such as leaf spots, blights, etc., e.g., early and late blights of potatoes and tomatoes caused by *Alternaria solani* and *Phytophthora infestans* respectively.

Microbial metabolic products such as streptomycin are known to inhibit chlorophyll synthesis. Some such as chlortetracycline, oxytetracycline, chloramphenicol and alternaric acid induce chlorosis in plants. These changes bring about a definite reduction in the carbohydrate build-up in host tissues.

Facultative parasites are known to cause marked increases in the respiration of the host tissues, even at considerable distances in advance of the invading hyphae, although similar effects are produced by obligate parasites also.

The examples given are taken to indicate that host-carbohydrate forms one of the substrates essential for the *modus operandi* of the facultative parasite which quite often brings about also a derangement in photosynthesis and carbohydrate build-up in host plants indirectly. In most diseases due to facultative parasites there is either a direct breakdown of the carbohydrates and other host components or else products of the pathogen or pathogen-host (carbohydrate) interaction function in the physiological derangement leading to the disease syndrome.

Successful obligate parasitism, on the other hand, depends on a ready supply of the substrate (including carbohydrates) to the invaded cells at a rate high enough to maintain their organization and metabolism in the presence of the parasite which cannot live on dead tissue. Continued growth of the parasite on the host is possible only when there is a balance between the relative rates of utilization and supply of the substrates.

3. D. SUBRAMANIAN (Madras): *Carbohydrate Metabolism and Host-Parasite Relationship.*

Unlike the obligate parasites the facultative parasites derive nutrition from their hosts from dead or wounded host cells around the infection court. Under these circumstances the susceptibility or otherwise of the host for the development of disease would depend on the availability of suitable conditions favouring the growth of the organism and secretion of enzymes which are necessary for its advancement. In wilt diseases and fruit rots the important role played by pectolytic enzyme systems of the respective pathogens has been stressed by many workers. The conditions prevalent in the tissues of the susceptible host should, therefore, be favourable to the production and activity of these enzymes, such as an optimum concentration of pectic substrates and an adequate supply of other suitable carbon sources, the availability of which is largely determined by the carbohydrate metabolism of the host plants. These facts are illustrated by citing the examples of *Fusarium* wilt of cotton (*Fusarium vasinfectum*) and fruit rot of chillies (*Colletotrichum capsici*). The low pectin content of the roots of *Gossypium hirsutum* (resistant to wilt) compared to the high pectin content of *G. arboreum* (susceptible) is traceable to the fundamental differences in the carbohydrate metabolism of the two varieties. Amendment of the soil with zinc shifts the carbohydrate metabolism of the susceptible variety (K2) in such a way that it compares with that of the resistant strains. The function of zinc appears to be to improve the water status of the susceptible strain which is known to be inherently deficient in this metal.

Pectic enzyme secretion by *Colletotrichum capsici* *in vivo* appears to depend upon not only the availability of pectin but also on the nature and quantity of sugar available in the host tissues. The susceptibility of the ripe fruit to attack by the fruit rot organism seems to be controlled by this factor.

4. S. SURYANARAYANAN (Madras) : *Rambling thoughts in the carbohydrate metabolism of phytopathogenic fungi.*

In reports of carbon utilization by fungi it is the usual practice to study the carbohydrates at a fixed concentration. Recent studies in this laboratory on *Sclerotium oryzae*, the stem rot fungus of rice, has indicated that different carbohydrates have different concentration effects possibly arising out of the trace element/growth factor impurities in the carbohydrates themselves which go to make up the apparent deficiency of the basal medium with reference to these factors. It is needless to emphasize the role of Zn and Thiamine in carbohydrate dissimilation by fungi. Yet another aspect of the carbohydrate nutrition of fungi is their response to a mixed carbohydrate supply. Dulcitol which is not utilized by *S. oryzae* when supplied alone is assimilated by the fungus in the presence of maltose. Though it is presumed that when more than a single carbohydrate is present certain key intermediates are produced which becomes otherwise unavailable, our knowledge on the metabolic events with mixtures of carbon sources is meagre or fragmentary. Similarly, the ability of *S. oryzae* to utilize galactose but not its corresponding alcohol, dulcitol, indicates that molecular configurations are at play in the carbohydrate nutrition of fungi. We know very little in this regard. Again, the carbohydrate metabolism of a fungus should be considered with its N metabolism in juxtaposition. *S. oryzae* is able to utilize better ammonium phosphate than ammonium carbonate. The superiority of the PO_4 salt over the CO_3 is evidently a case of the role of P in sugar phosphorylation and formation of the necessary α -ketoacids to combine with the ammonium N. Though it is assumed that different pathways of carbohydrate utilization may be followed by fungi depending on the type of N source, much more needs to be done in this line. Finally, the synthetic capacity of the blast fungus of rice, *Piricularia oryzae* to synthesize thiamine from its simpler fraction pyrimidine may be mentioned as another instance where the type of substrate sugar governs the biosynthesis of the vitamin by the fungus. Thiamine is synthesized by this fungus from pyrimidine alone when the carbohydrate is maltose but not glucose. This is surprising inasmuch as a disaccharide like maltose is finally hydrolyzed to glucose only. Though it may be assumed that pyrimidine is active only with the form of γ form of glucose much remains to be done on the inter-relationships between the nature of carbohydrates and thiamine biosynthesis by fungi.

The above few instances clearly indicate the need to direct more critical studies on the carbohydrate metabolism of fungi especially with mixed carbohydrates since pathogenic fungi seldom encounter a single carbon source in their hosts.

5. T. V. DESIKACHARY (Madras) : *Some aspects of Carbohydrate Metabolism in Algae.*

It is proposed to deal in this paper with the locus of photosynthesis in some algae, the chloroplast. The chloroplasts and the chromatophores (including here the chromatoplasm also) are the bodies within the algal cell which have been related with the function of carbohydrate (or starch) formation. These have received very great attention from morphologists and a good deal of work has been published in recent times. The algal chloroplasts, though in many respects resemble those of the higher plants, differ from them in their microstructure.

The pigment content of these pigment bearing bodies differs quantitatively and qualitatively in the various algal phyla, though green algae show a great similarity to the higher plants.

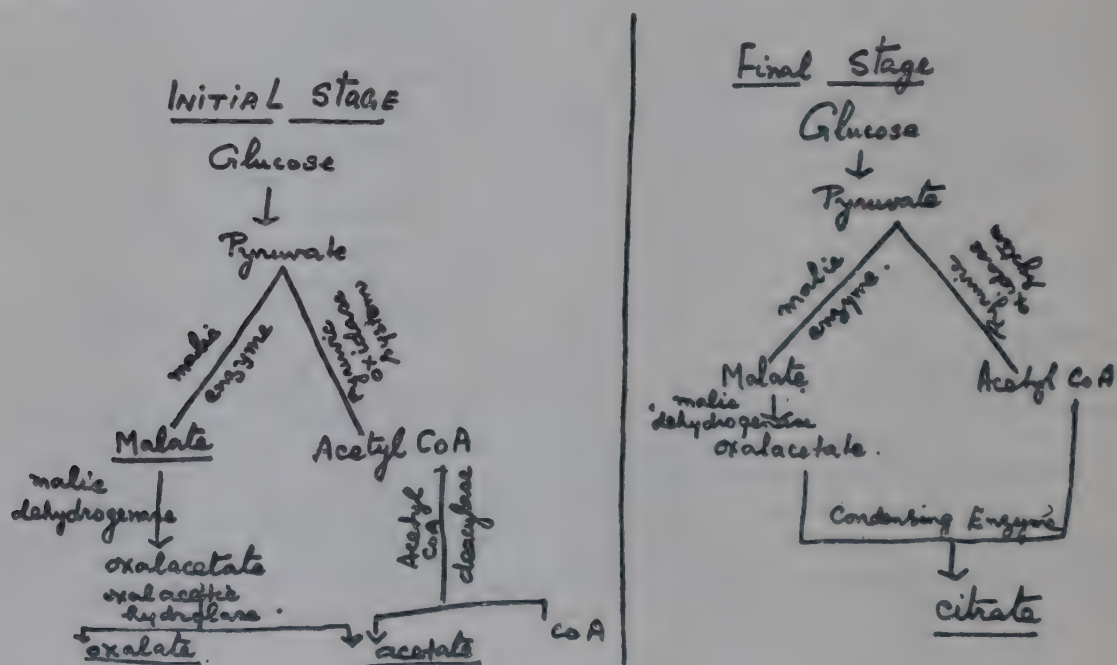
Starch formation has been related to the pyrenoid by a number of workers. Some differentiate the starch as pyrenoid starch and the stroma starch, while others do not agree with such a differentiation. The details of starch formation are given.

6. C. V. RAMAKRISHNAN (Baroda): Biosynthesis of citric acid in *Citrus acid*.

Studies carried out in this laboratory show that the fruit tissue of *Citrus acid* is a specialised form of tissue in that it possesses all the enzyme systems necessary for the conversion of glucose into organic acids.

Analysis of the fruit tissue at various stages of development shows that the glucose content decreases as acidity increases and that the organic acid pattern changes with developmental stage.

In the initial stages accumulation of oxalate and malate occurs but not of citrate. As the fruit ripens oxalate disappears altogether while there is accumulation of large amounts of citrate together with a small amount of malate. Detailed enzyme studies show that in the initial stages there is high activity of oxalacetic hydrolase and acetyl CoA deacylase and a low activity of the condensing enzyme whereas the later stages are characterised by the disappearance of the first two enzymes and a great increase in condensing enzyme activity. This would appear to account not only for the non-accumulation of citric acid in the early stages and its accumulation in the later stages but also for the accumulation of malate and oxalate in the early stages. The suggested mechanisms are schematically shown below:—

7. S. N. BHARDWAJ (Agra): Influence of NaCl and Na_2CO_3 on some aspects of carbohydrate metabolism in wheat.

Influence of supplying NaCl and Na_2CO_3 , in injurious concentration, has been investigated on carbohydrate metabolism in wheat (C. 591) at the seedling stage as well as in grains produced by 'salt-fed' plants.

It is concluded from the results that a supply of the chloride or the carbonate brings about a disturbance in carbohydrate metabolism. Sugars are lowered by the treatments, compared to the control, at the seedling stage and also in the grains produced. Starch/sugar ratios, estimated for grains only, are increased. Na_2CO_3 , compared to NaCl, reduces the sugars to a greater extent as observed both at the seedling stage and in the grains. Further, starch/sugar ratio in the grains was increased more by the carbonate than by the chloride.

Thus, it appears that carbohydrate metabolism is affected to a greater extent by the alkali salt (Na_2CO_3) than by the chloride.

8. I. S. BHATIA, T. SATYANARAYANA and LATE PROF. K. V. GIRI (Bangalore) : *Carbohydrate Metabolism of Plants I. Biosynthesis of gluco fructosans in 'Crinum longifolium'.*

An enzyme has been isolated from the tubers of *Crinum longifolium* which catalyzes the transference of fructosyl residues from a donor sucrose to an acceptor sucrose molecule, thus :



Arabinose and xylose are able to successfully compete with sucrose as acceptor molecules. Xylose gives rise to two oligosaccharides occupying positions between sucrose and F_2G and F_3G . Similar reactions have been previously reported only with bacterial enzymes. Glucose does not inhibit the reaction. Raffinose acts as the substrate and two spots of lower R_f than that of raffinose are synthesized. Fructosan (F_1) isolated from *Agave vera cruz* and inulin (B.D.H.) are not hydrolysed by the enzyme. When a mixture of trisaccharide and tetrasaccharide isolated from the water extract of *Crinum longifolium* by column chromatography using charcoal-celite column were used as substrate, no reaction took place : neither synthesis nor hydrolysis.

The active enzyme can be obtained in the powder form by precipitation of the dialysed extract with alcohol, though with considerable inactivation.

No coupled reaction exists between sucrose (as the donor of fructosyl residues) and rhamnose, maltose and lactose as the acceptor of such residues.

9. DR. J. J. CHINOY : *Carbohydrate metabolism in plants.*

In the first instance I wish to ask two questions : 1. Were the experiments carried out under controlled conditions of nutrition?; and 2. Were the plants grown in the soil or pots?

On the basis of data of a number of workers Dr. Subramaniam has postulated that fusaric acid formed by the wilt parasite adversely affected the photosynthetic mechanism of the host plant. Synthesis of chlorophyll is also supposed to be retarded by fusaric acid.

The symptoms attributed by Dr. Subramaniam to the toxic effect of fusaric acid, viz., reduction in carbohydrate level, increased respiration, increase in amino acids, reduction in chlorophyll content, pigment formation, and others are the very symptoms of extreme potassium deficiency in the host plant described by Dr. F. G. Greyely and his collaborators more than 20 years ago. This is further substantiated by the data of potassium contents of control and diseased plants cited by Dr. Subramaniam. The K-content of diseased plants was found to be one-thirtieth of the healthy ones.

It, therefore, appears to me that the dislocation of photosynthetic mechanism attributed to the toxicity of fusaric acid may be a direct effect of potassium deficiency. The question of experiments made under controlled conditions of nutrition assumes great importance in this context.

Dr. Sadasivan has also suggested that the lowering of chlorophyll content is sudden during the seedling stage and this is the probable cause of dislocation of the photosynthetic mechanism. In this connection it is well to remember that Willstatter and Stoll working with a large number of plant species found that wide variations in the chlorophyll content did not affect the rate of photosynthesis.

IV. EFFECT OF CHEMICALS ON CELL DIVISION

(Jointly with the Section of Zoology & Entomology)

Chairman: DR. R. MISRA, Banaras.

1. P. N. MEHRA (Amritsar): *Effect of chemicals on cell division with particular reference to colchicine effect on sporeling germination in ferns and abnormal spermatogenesis.*

During the last two decades a large number of chemicals including auxins, hormones, vitamins and a variety of plant products used in medicine to alleviate human sufferings have been tried for their effects on mitosis and cell division—processes that govern the fundamentals of life. According to their action they are classified into (1) Substances which cause inhibition of preprophase mitoses, (2) Those that act as prophase poisons causing reversions to resting nuclei, (3) Carcinogenic compounds that cause unrestricted proliferation of cells, (4) Those that stimulate organised cell divisions like the auxins, (5) The spindle inhibiting substances which include a variety of chemicals, the most outstanding of which in its practical application is colchicine, (6) Substances responsible for initiating multipolar spindles like Athanol, (7) Substances inhibiting only the phragmoplast or cell plate formation, (8) Chemicals mutagens that have their action on genes or some restricted loci of the chromosomes of a genome—an action which is cytologically cryptic, (9) Radiomimetic substances which are responsible for visible chromosomal aberrations like breakages and reunions and (10) Those which exhibit multiple effects with a preponderance of some of them at certain specific concentrations. Besides the very numerous practical applications that these studies may lead to or have led to, their importance in solving many of the mysterious processes of mitosis and meiosis cannot be overemphasised. Equally important is the study of morphogenetic development of cells that have been so affected by these substances. Unfortunately this aspect has not received the attention it deserves. It is to this latter aspect that I shall confine my attention.

Effect of various strength of colchicine has been tried on sporeling germination of several species of leptosporangiate ferns some of which are diploid and others tetraploid. The germ papilla becomes intensely swollen and balloon-shaped in all these, because of polyploidy. Chloroplasts retain the original size, but increase in number considerably. The rhizoids become irregular, dichotomise once or several times presenting a tufted branched appearance, or in some cases become alternately pinnate branched with perfect regularity but all the time remain uninucleate. *Goniopteris prolifera* and *G. multilincatum* are diploid and form normal haploid gametophytes in nature. The colchicine induced diploid gametophytes conform to the normal pattern of structure and development except for the large size of the cells and the sex organs. Spermatogenesis is perfectly regular resulting in large diploid sperms about double in volume compared to the haploid ones and with longer and more numerous cilia. The induced tetraploid gametophytes lose the capacity for expansion to form typical heart-shaped prothalli. They remain filamentous and consequently lack archegonia but produce antheridia which have the usual structure but for their very large size. The number of spermatocytes is decreased to roughly half the usual number. The most interesting feature is the abnormal spermatogenesis resulting in the formation of twins, triplets, quadruplets, double headed or double tailed monstrous sperms or those with several arms. Cytological investigations show this to be the result of amitosis or fragmentation of the tetraploid nucleus within the spermatocytes. Apparently, therefore, these sperms are of diverse genetic constitution but all the same they are motile. In only rare cases gigantic tetraploid sperm of normal shape may develop within a spermatocyte. The behaviour of colchicine induced tetraploid prothalli or the tetraploid species like

Dryopteris subpubescens and *Pteris vittata* is on the whole similar to that of tetraploid gametophytes of *Goniopteris* sp. both in the form of the gametophyte and the abnormal spermatogenesis. Archegonia have so far not appeared on the tetraploid prothalli.

It is concluded that at least in the species worked out only two genomes sets can function harmoniously to give rise to the normal looking gametophytes which produce apparently functional sex organs. Increase in the number of genomes brings about a serious disturbance in vegetative growth and reproductive cycle. Also the organisation of spermatozoid and its motility does not seem to be necessarily related to its regular genetic make up.

9. S. MOOKERJEE and M. G. ALAMELU (Calcutta) : *Nuclear Cytoplasm Separation in N. Ethyl-urethane treated Amoebae.*

Nucleo-cytoplasmic balance in a cell can be disturbed by administering various chemicals. Urethane is one such suitable chemical which has a variety of actions on the different components of a cell. Urethane has been experimented upon amoebae to see what variety of effects it can possibly produce in amoeba and also how the amoebae behave subsequently after treatment.

1% urethane has been found to be the most effective dose.

Repeated treatment by urethane show mainly two types of novelty in the nuclear-cytoplasmic separation of amoebae. The immediate effect of urethane treatment results in an increase of binary fission. When these amoebae are again exposed to urethane in their second subculture, a multinucleate condition i.e. division of the nucleus at a faster rate than the division of the cytoplasm is noticed. However, repeated treatments by urethane for 3 to 4 successive subcultures produced opposite effect and result in a failure of the nuclear separation in them. The nucleus of these amoebae appears to be pulled out into an enormous size without completing their mitotic cycle. Often the nucleus is left out as a string and the two amoebae lie separated.

3. J. VENKATESWARLU (Waltair) : *Comparative effects of Colchicine and some Plant Alkaloids on Mitosis in root tip cells of Allium cepa L.*

The course of mitosis in root tips of *Allium cepa* grown in water, colchicine, and in eight plant alkaloids, not tried before, namely, acidic cinchophene, sodium salt of cinchophene, cocaine, rhamnose, thevatin, nerifolin, berberine and digitalinum verum was studied.

Colchicine treatment on *Allium cepa* roots showed, besides the occurrence of previously recorded phenomena like C-mitosis, reductions and reversions, a new colchicine effect, namely, formation of bridges due to non-separation of chromosome ends. Quantitative estimates of polyploidy and other phenomena noted above were evaluated.

Results of quantitative studies with the eight plant alkaloids are classified and described as under : Lethal zone, Narcotic zone and Sub-Narcotic zone according to the types of aberrations produced.

Lethal Zone : Comprises the development of (a) washing out of chromatin of cells (alkaline sodium salt of cinchophene), (b) sticky bridges (acidic cinchophene), (c) dispersion of chromatin into the cytoplasm through breakage of nuclear membrane (colchicine, acidic cinchophene and rhamnose), (d) highly pycnotic resting nuclei with increase in the nucleolar size (rhamnose, cocaine, acidic and sodium salt of cinchophene and berberine), (e) despiralization and aggregation of chromatin at the ends of metaphase chromosomes (cocaine and nerifolin) and (f) reversion to resting stage from division phases (colchicine, sodium salt of cinchophene, cocaine, rhamnose, nerifolin and berberine).

Narcotic Zone: Only sodium salt of cinchophene compares with colchicine in being a specific inducer of C-mitosis, while the rest are not. Segregations were noted in all the chemical treatments.

The chemicals act on the spindle as suppressors in three ways: (1) complete, leading to polyploidy, (2) partial, leading to reductions and segregations and (3) delayed, leading to irregular orientation of chromosomes.

Sub-Narcotic Zone: Fragmentations and erosions (acidic cinchophene), fragmentations and pseudo-chiasmata (sodium salt of cinchophene), mis-division of the centromere (colchicine and cinchophene) and inhibition of cytokinesis (acidic cinchophene, cocaine, rhamnose and digitalinum verum) were the chief radiomimetic effects noted in the sub-narcotic zone.

4. RAMAKANT P. PATIL (Allahabad): *The effect of Sodium Nucleate on Mitosis in Root Tips.*

During cell division nucleic acid is localised exclusively in the chromosomes and increases in the prophases of mitosis, later diminishing at the termination of the division (de Robertis *et al.*, 1949). An extra supply of nucleic acid during nuclear division upsets the normal nucleic acid balance and produces anomalies in the mitosis.

Huskins (1948) first drew attention to the occurrence of "reductional groupings" in the onion root tips treated with sodium ribose nucleate. Hersheopf (1949) confirmed that sodium nucleate increased the frequencies of "reductional groupings" in *Tradescantia* root tips. Agents other than sodium nucleate are now known to increase the frequency of "reductional groupings" which may undergo a "second division" with spindle formation.

In onion root tips affected by varying concentrations of sodium nucleate Kodani (1948) observed sticky chromosomes, chromosomes with "lampbrush" effect, contracted and thickened metaphase chromosomes, c-metaphases and irregular anaphases. Kodani inferred that the treatment enormously prolonged the mitotic cycle.

Patau and Patil (1951) working with *Rhoeo* and 8 per cent sodium nucleate found that as the treatment progresses there was

- (1) a decline in frequency of early prophase.
- (2) an accumulation of late prophase figures on account of the decrease in the rate of transition from late prophase to metaphase by a factor of about 10 in the first two hours
- (3) slowing down of metaphase
- (4) a strong decrease in frequency of anaphases and telophases within first two hours
- (5) increase in percentage of late prophase nuclei with short chromosomes and a correlated increase of short chromosomes at metaphase.

If one supposes that reductional groupings at prophase arise as mere random arrangements of the chromosomes, the prolongation of late prophase (a) gives more time for chromosomes to assume random positions, (b) permits clear-cut demarcation of such random groupings by the shortening of the chromosomes.

In regard to radio-mimetic effects, there is no evidence that sodium nucleate induces chromosome fragmentation nor, apparently, gene mutation.

5. R. S. PATHANIA (Amritsar): *The effect of Sodium Nucleate on Mitosis in Ephedra.*

Root tips of *Ephedra gerardiana* ($2n=14$) and *E. foliata* ($2n=14$) were treated with 1-20% solutions of sodium nucleate (B.D.H.) in distilled water. Fixations were made at 4-48 hourly intervals, and Feulgen squashes were prepared,

Concentrations of 1-5% had apparently no cytological effect. Spindle formation was normal and anaphasic separation of chromosomes was regular.

6% solution gave a weak c-mitotic effect, only in some of the cells the spindle formation was inhibited and the chromosomes were scattered at the ensuing metaphase. In this concentration even for the full period of treatment of 48 hours, the chromosomes became only slightly shortened compared to their size at normal metaphase.

In 8% concentration besides some scattered metaphases, it was seen that the chromosomes tend to become sticky and at the ensuing anaphase it was common to see equatorial bridges.

In 10% solution c-mitotic action of the drug was complete, exceedingly few normal mitoses occurring. In this concentration there was frequent occurrence of "distributive c-mitosis".

In 12% solution c-mitotic effect of sodium nucleate was more pronounced. The chromosomes became shortened and thickened. Stickiness was more marked than in previous concentrations and it was not uncommon to see sticky c-metaphases. Variants of the c-mitosis like the "ball" metaphase, "star" metaphase were also encountered.

In the 16% solution great stickiness of chromosomes, chromatic agglutination, and chromatin droplets were observed. Micronuclei were quite commonly formed.

20% (saturated) solution is characterized by the highly liquefied nature of chromosomes and the formation of chromatin droplets. The stickiness of chromosomes is so pronounced that the identity of individual chromosomes is lost, all of them forming one mass. Irregular nuclei and at times amitotically dividing nuclei were also encountered.

6. I. K. VASIL (Delhi) : *Effect of Nucleic Acids on Cell Division in Excised Anthers.*

A correlation between the development of microspore mother cells and the synthesis of nucleic acids in anthers is indicated by the work of several investigators. In most plants, the meiotic synthesis of DNA is completed by diplotene so that anthers excised at or after diplotene can be cultured without much difficulty. Cooper (1952) and Linskens (1958) state that during meiosis DNA is transferred from the tapetal cells to the microspore mother cells probably in the form of nucleotides. Further, Taylor & McMaster (1954) and Moses & Taylor (1955) have shown that during pollen development DNA synthesis occurs at three specific stages. In view of these investigations, it was thought worthwhile to study the effect of nucleic acids on the survival and development of excised anthers *in vitro*.

Anthers of *Allium cepa* and *Rhoeo discolor* were cultured aseptically in modified White's medium (WM) supplemented with ribonucleic acid (RNA) and desoxyribonucleic acid (DNA) at 5, 10, 25, 50 and 100 mg/l.

In anthers of *Allium cepa* excised at leptotene-zygotene and cultured in WM with 50 mg/l RNA, 98 per cent of the mother cell formed tetrad in four days while only 2 per cent degenerated. In the same medium, if the excision was made at diplotene-diakinesis, all the mother cells formed tetrads in four days. DNA did not prove to be as useful as RNA although 65 to 75 per cent of the mother cells did survive up to meiosis II and some even formed tetrads. In contrast, there was no growth in the basic medium.

In *Rhoeo discolor* optimum development was obtained with RNA (25 mg/l). Culture of anthers excised at leptotene-zygotene showed 3 per cent undeveloped mother cells, 76 per cent dyads and 21 per cent tetrads in two days. However, when cultured at diplotene-diakinesis, all the mother cells formed tetrads within one day and 1-celled microspores in two days. Also, *in vivo* the tetrads are formed in 48 hours while *in vitro* the time required is only 24 hours.

Skoog (1954) states that the growth substance inducing the differentiation of tobacco stem segments is intimately concerned with the nucleic acid metabolism. In tobacco pith tissue, Silberger & Skoog (1953) have shown a "correlation of cell division with DNA increase at low concentrations of IAA". Sharma & Sen (1954) and Hildebrandt *et al.* (1957) have also reported an increase in cell divisions and growth of plant tissues with RNA.

This work was carried out in a Scheme on "*In vitro* culture of plant organs" sponsored by the Council of Scientific and Industrial Research, New Delhi.

7. M. S. SWAMINATHAN, A. T. NATARAJAN and K. A. PATEL (New Delhi):
Effect of some vegetable oils on cell division.

Chromosome and chromatid breaks, "error" configurations, binucleate cells with or without synchronised mitosis and spindle abnormalities were observed in root tip cells of einkorn, emmer and bread wheats treated with groundnut, mustard and castor oils. Though reunion following chromosome breakage appeared to be rare in mitotic plates, multivalent associations and dicentric bridges were seen during microsporogenesis thus indicating that delayed reunion may occur. Certain other oils like coconut and Sesame oils were markedly less potent with regard to their ability to induce chromosome aberrations.

To identify the fraction which induces chromosome breakage, groundnut and castor oils were fractionated and the effects of the different fractions studied by "*Allium test*". These fractions consisted of components of least soluble, intermediate and most soluble mono, di and tri-saturated and unsaturated glycerides ranging in different proportions in the different fractions. It appears from the data that it is the unsaturated glyceride portion which has the maximum effect on cell division.

It is interesting that a wide variety of chemicals can upset cell division and induce chromosomal aberrations in plants. However, most of these chemicals have not been found useful to induce viable mutations in plants. Apparently, their effect either disappears when the treatment is withdrawn due to processes of intracellular repair or intra-somatic selection.

Many oilseed plants such as *Brassica*, linseed and Sesame are highly resistant to radiations. It is probable that plants containing mutagenic chemicals are less sensitive to radiations than those without them. If correct, this will be an interesting evolutionary feature. Another important bearing which the study of the effects of chemicals on cell division has on mutagenesis, is in relation to radiation protection and recovery. It is now evident that in bacteria there is variation in response to chemicals that protect against radiation. Certain strains of *Escherichia coli* are well protected by Cysteamine while others are not. Another development is the discovery that some protective chemicals enhance the mutagenic activity of X-rays. Finally, it has recently been found by workers in the United States that rejoining of breaks may be accelerated by giving the cell an energy source after exposure. The energy is derived from reactions that are dependent on a supply of oxygen or it may be furnished to the cell by adding adenosine triphosphate. Thus chromosome breaks can be encouraged to rejoin after irradiation by suitable chemical treatments. The study of the effects of chemicals on cell division has therefore far-reaching implications in radiation protection and recovery.

8. S. P. VENKATASUBBA RAO: *Effects of Urethane on the chromosomes of Poecilocara Pictet*.

Urethane (2%) under certain conditions brings about a most spectacular phenomenon of "bivalent stretch" (after 24 hours treatment) at first meiotic metaphase. This we feel is the first record of the induction of "bivalent stretch" by chemicals.

On the normal course of events an almost parallel case of "bivalent stretch" occurs during the meiotic in several insects belong to Mantidae, Phasmidae, Blattidae, Gryllidae and Coleoptera. By some it is considered to be due to a precocious response of the kinetochore to the poles. However, Ostegren (1951) feels that it is a universal phenomena found in all organisms exhibiting co-orientation of bivalents. The "stretch" is more prominent in some but less in others.

In the case of "stretch" induced by Urethane, the chemical affects the 'optimum spiroilization' but not the activity of the kinetochore. The kinetochore activity remains normal. There are also instances where at the same concentration (2%) Urethane brings about superconcentration of the chromosomes (after 6 hrs. treatment) both in mitotic and meiotic metaphases. In this case though the kinetochore activity remains active, the chromosome due to over spiralization resist the kinetic activity and thus remains supercontracted.

A more detailed study of induction of "stretch" however, will help in the better understanding of the mechanics of meiosis.

2. Y. S. R. K. SARMA (Varanasi) : *Effect of Colchicine on Algae.*

Compared with the extensive literature on the application of colchicine to the flowering plants, similar work on algae is very scanty (cf. bibliography in Bigsti & Dustin, 1955). Of those who studied the effect of this alkaloid on the latter group, Tschermak (on *Oedogonium* sp.), Wetherell and Krauss (on *Chlamydomona reinhardt*) and Sharma (on *Sphaeroplea annulata*, *Hydrodictyon reticulatum* and *Microspora loefgrenii*) succeeded in inducing Colchicine-polyploidy. From the studies of the previous workers and the present author certain differences in the behaviour of algae and flowering plants towards colchicine become evident.

While even extremely low concentrations of colchicine can block ordinary mitosis in many higher plants and animals, low concentrations appear to be ineffective in several algae (cf. Cornmann, Jakob, Kallio and others). In some cases, only saturated solutions after a prolonged treatment proved effective (Godward on *Spirogyra crassa*). In others a concentration of 1% was found to induce polyploidy (cf. Wetherell and Krauss, and Sarma), the times of exposure, however, being different in different species. In Euglenineae, mitosis seems to be unaffected by any concentration of colchicine (cf. Leedale).

Thus algae, in general, seem to differ from flowering plants in their low susceptibility to colchicine. Such a high degree of tolerance can only be matched by some Fungi, Bacteria and *Colchicum* in angiosperms. Although Leavan and Levring, and Cornmann tried to explain the inefficacy of colchicine in certain algae, they do not provide a complete answer for the different types of behaviour since, as Brachet (1958) points out, "the biochemical action of colchicine has not yet been discovered."

Another feature of colchicine polyploidy in algae appears to be the absence of any c-pairs characterising c-mitosis of higher plants. In none of the algae investigated by the present author, even in groups with increased chromosome number have parallel lying chromatids—'ski-pairs'—ever been observed.

A highly significant feature observed by the author in *S. annulata* was that greatly deficient, aneuploid, and polyploid nuclei were found to be capable of survival and repeated division in the cytoplasm of the coenocyte.

Perhaps, the events occurring in algae do not fit exactly with those described as typical of c-mitosis in higher plants, in spite of some common features recorded at least in a few, such as chromosome doubling, interference with spindle formation, septum formation etc. It is possible to conceive of different types of c-mitosis to be present in different algae to explain the differences in their behaviour towards colchicine.

1. INTERPRETATION OF ARCHAEOLOGICAL ANTIQUITIES, (a) PRE-HISTORIC AND PROTO-HISTORIC, AND (b) ETHNOLOGICAL DATE

Section of Anthropology and Archaeology

Chairman: SHRI V. D. KRISHNASWAMI, Delhi.

In the absence of Dr. S. S. Sarkar, Prof. N. K. Bose initiated the discussion and said that more care should be taken while looking into the date regarding climate and strata formation on river banks. He also stressed the need of being careful in correlating the glacial with the pluvial period and pointed out the need of collecting primary data before coming to any conclusion. About ethnological data, Prof. Bose felt that the technique and form of pottery should not be rashly correlated with the state of culture in which the pottery is found. He further stated that the importance of studying the present day pottery-making in an area lies in establishing the continuation of culture in that particular area.

Dr. S. C. Sinha mentioned the presence of stray palaeoliths, a neolith and some iron smelting sites in an area in south Bihar occupied by the Bhumij tribe, and said that the local people claimed that the iron smelting site was actually functioning within the knowledge of their forefathers. He said that a systematic excavation of such sites containing monoliths etc. would possibly throw some valuable light on the past of the people who occupy that area at present.

Dr. P. E. P. Deraniagala citing the example of the "Sohan" type of tools in Ceylon, which are stratigraphically of more recent origin, warned against making hasty conclusions about the age of pleistocene tools on a typological basis. Sri B. B. Lal broadly agreed with Dr. Deraniagala.

Dr. A. K. Chaudhuri spoke on the value of excavated wood as indicators of climatic, domestic economy and dendrochronology. But, he warned that, since good rainfall hastened the growth of tree-rings, as also since the time required for the formation of rings differ in different trees, the chronological correlation has to be made very carefully.

The discussion was summed up by the President Sri V. D. Krishnaswamy.

2. CULTURAL INTEGRATION OF INDIA

Chairman: SHRI V. D. KRISHNASWAMI, Delhi.

DR. U. R. BARON EHRENFELS (Madras):

Initiating the discussion, Dr. Ehrenfels spoke about the influence of European style of dress on Indians and its social implications. He stated that although the adoption of the European style of dress by the Indians is to some extent responsible for industrialization and democratization, it has also brought about in its wake a lack of integration because of the distinction of status that comes from the use and non-use of it. He also pointed out the unsuitability of clothes like shirts, trousers and neck-ties in India's tropical climate.

Dr. Charles Swan of Michigan (U.S.A.) voiced the opinion that the adoption of a certain type of dress, which is a case of social adjustment only, does not indicate lack of integration. He further stated that instead of decrying a style of dress, the most suitable dress for national use should be found or evolved, and its conscious adoption should be brought about. But so long a highly prosperous situation, where everyone can afford to choose and select the most convenient dress for himself, does not come, the problem of dress as an indicator of status would remain.

Dr. S. C. Sinha said that the title of the symposium and the subject of the initiator's talk have hardly anything to do with each other, and so, he suggested

that, Prof. Bose should initiate a complementary discussion on the existing integration of India.

Prof. N. K. Bose said that from time immemorial there has been certain ritually sanctioned styles of dresses in India. The unsewn cloth (dhoti and chaddar) is worn in the south and south-eastern India, while in the north and north-western India the use of sewn clothing (trouser type) is found, and these two zones meet at an area where the unsewn cloth is worn like trouser (e.g. the Bengali way of wearing dhoti). These two zones also differ from one another in the use of some other traits of material culture too, like the design of footwear, type of oil used for cooking, use of wheat or rice, etc. Prof. Bose postulated that these traits have travelled with religions and moral ideas.

Dr. S. C. Sinha spoke on integration on a regional level, and for his example, he chose the Manbhum District in Bihar, which is largely inhabited by the Bhumij tribe. Here, nearly 23 castes and tribes live on a give-and-take basis in the ritual and economic spheres of life. As a result, the thorough study of the customs of any one group, say most of the Bhumij tribe, automatically covers large portions of customs of, say, the Brahmins, Kurmis etc.

Dr. Ehrenfels summed up the discussion.

3. SOCIAL ANTHROPOLOGY IN THE STUDY OF RURAL, URBAN AND HISTORICAL COMMUNITIES

Chairman : SHRI V. D. KRISHNASWAMI, Delhi.

M. S. A. RAO (Delhi) :

This subject was already partly discussed in an earlier symposium in the 44th Session held in Calcutta.

Sri Rao said that the criticism usually levelled against the social anthropologists are, first, a lack of extensive quantification of data in social anthropological work; secondly, lack of adequate controls for ensuring a hundred per cent dependability of techniques adopted, and lastly, that the results are usually not verified and are not broadly applicable.

These shortcomings, Sri Rao felt, could easily be got rid of by rejecting undependable methods and by using techniques for cross-checking the data. He said that since the social anthropologists themselves are aware of these limitations, they shall be able to make great strides forward in the future.

Sri S. K. Navlakha said that the difference in the method of collecting data in different regions have largely resulted due to the local conditions and the facilities available in the particular regions.

Dr. S. C. Sinha, citing his own work among the Bhumij of the Manbhum District of Bihar, said that the study of the land tenure system is a convenient and dependable basis for looking into the past of a community.

Sri Indra P. Sinha and Sri Gopal stated that in the questionnaire method used by them, they found that the attitude of the informants towards the subject of a particular question tended to colour the answer.

Prof. N. K. Bose selected five recent works in social anthropology to deal with the rôle of social anthropology in the study of rural, urban and historical communities, and pointed out the different degrees of success, or its absence, attached in each of them. These five works included Bery's "Caste and economic frontier", the evaluation of reports of the Government of India on the Community Development Projects, Dr. Srivastava's book on the Tharus, Marriott's work on a pilgrim centre in Maharashtra, and Ray and Patnaik's work on the temple administration in Bhubaneswar (Unpublished).

Prof. Bose ended by saying that, firstly, as theoretical social scientists, an anthropologist poaches into out of bounds ground when he suggests means for the upliftment of the people he is studying. Secondly, for a successful work, the field-worker must identify his spirit with that of the community he is studying. And lastly, quick publication of results of experimental studies goes a long way in helping the other workers in the same field, who may achieve greater degrees of success by comparing notes.

The discussion was summed up by the President Sri V. D. Krishnaswamy.

I. CONTROL OF ZOONOSSES IN INDIA

Section of Medical and Veterinary Sciences

Chairman : SHRI P. G. PANDE, Izatnagar

The Chairman introduced the subject of the symposium by stating that the term 'zoonoses', although fairly new in the vocabulary of public health and veterinary medicine, was a useful one to denote diseases of animals transmissible to man and *vice versa*. Even though such diseases number more than eighty, only 10 or 15 could be said to occupy a position of importance. In view of the heavy public health and economic toll exacted by the zoonoses, there was urgent necessity for finding out the most effective means of combating these maladies, which, in his opinion, could be accomplished only by a combined veterinary and medical approach, utilizing the full resources of these departments. There could be little doubt, he said, as to the usefulness of bringing together veterinary and medical workers—whether their work was in administration, in the laboratory or in the field—to discuss topics of common interest and particularly did this apply to zoonoses. He requested Dr. J. A. R. Miles to open the symposium on this subject of great national and international importance.

(1) Dr. J. A. R. Miles (W.H.O./Department of Microbiology, University of Otago, New Zealand) opened the symposium with the following remarks: The prevention and control of zoonoses in human beings could be accomplished in large part by control of these diseases in animals, thus necessitating close co-operation and mutual assistance—moral, financial, scientific and educational between public health and veterinary workers in carrying out successfully animal disease control programmes. He said that the contribution which could be made by veterinary authorities in tracking down the source of infection (the animal), applying measures for control and eradication, co-operating in ecological surveys and educating the farmers was obvious. This problem of control and prevention of zoonoses was a very difficult one in India, especially so the control of stray dogs. Dog, amongst the domesticated animals, was the longest associated with man and was an important reservoir of transmissible diseases such as leishmaniasis, typhus, hydatid diseases etc., and their prevention needed in the first instance, the elimination of stray dogs.

Another point of importance in India that deserved immediate attention was the necessity to carry out full-scale ecological surveys of the flora and fauna before attempting schemes of colonization in erstwhile uninhabited semi-cleared forest areas. He illustrated the advantages that might accrue of such investigations with the example of the recently discovered Kvasanur Forest Disease, which had been observed to affect monkeys and man in the Shimoga District of Mysore State, India, the aetiological agent of which was identified by Work and Trapido (1957) as an arthropod-borne (arbor) virus of the Group B of Casals and Brown (1954) belonging immunologically to the Russian Spring Summer Complex. The attention

of public health workers was first drawn to this disease when monkeys were reported to have died in large numbers in the forest of the Shimoga District. When the work was started on a project for the construction of a dam in this region, a few village workers became sick in the dry season. The virus strains isolated from acutely ill human beings and from the tissues of recently dead monkeys were shown to be the same. This findings together with the earlier demonstration of anti-bodies in humans which were immunologically indistinguishable from those of Russian Spring Summer encephalitis in Saurashtra and possibly other parts in India by workers at the Virus Research Centre, Poona (Kerr and Gatne, 1954; Smithburn, Kerr and Gatne, 1954) suggested that there might be wide-spread, in the Asian tropics, a complex of Russian Spring Summer-like viruses and diseases which might have gone unnoticed. The work of the insect-collecting team led to the isolation of the Kyasanur Forest Disease Virus from pools of larval and nymphal ticks of the genus *Haemophysalis* and species *H. spinigera*, *H. turturis* and *H. papuana*. Such ecological surveys of the flora and fauna including aetiological and serological studies should prove of great assistance in finding out accurately the diseases, both actual and potential, that could appear in a region, so that necessary precautions for prevention and control could be undertaken in time to prevent the incidence and spread of such diseases.

(2) Dr. J. N. Maitra (Calcutta) pointed out the occurrence of cases of hepatitis in families keeping dogs, suggesting the possibility of transmission of yet another disease from dogs to man. The work on the control of stray dogs in cities, he said, should be intensified if it was desired to achieve some degree of success in this field.

(3) Dr. Oscar Felsenfeld (Department of Epidemiology, Walter Reed Army Institute of Research, Washington, D.C.) indicated the magnitude of the problem of salmonellosis in U.S.A. by stating that the majority of outbreaks were found to follow consumption of food directly or indirectly associated with infection of some animals. In U.S.A. birds, particularly chickens, turkeys and ducks were found to constitute the biggest known reservoirs of salmonellae with the result that practically every type so far met with had been isolated in cases of food poisoning in man. In China, he said, it was dog-borne. Work in Egypt showed a high carrier rate in dogs and cats. In India, it would appear, based on the little data available, human salmonellosis spread from man to man. However, it was possible that there might be more spread from other animals should eating of meat become more popular and community feeding a habit.

(4) Dr. T. N. Mathur (Karnal, Punjab) stressed the fact that several outbreaks of gastro-enteritis in humans went uninvestigated in India. Recently, *Salmonella weltevreden* was isolated from six cases of food poisoning in man. During the course of his work on brucellosis, he had collected so far sixteen cases of infection in human beings and the seven strains of brucellae so far isolated were identified as *Brucella melitensis*. He remarked that no report of work done by veterinarians had come forth on this economically important disease of animals. In his opinion, Leptospirosis was another disease that needed an immediate survey.

(5) Dr. P. Chandra Sekariah (Mukteswar-Kumaon) summarised the work on animal/bird salmonellosis carried out so far by workers in this field in India, which showed the interesting fact that cattle, sheep and goats so far investigated constituted not a less important reservoir of salmonellae than either fowls or pigs. He cited an interesting outbreak of food poisoning in human beings due to consumption of honey. *Salmonella florida* was isolated not only from the sick personnel but also from honey as well as the diseased larvae and pupae of the bees of the apiary from which the product came. This was the first authenticated instance of a disease process occurring in insects due to salmonellae, these being regarded earlier only as mechanical vectors. Rare serotypes like *S. oxford*, *S. banana*, *S. nchanga* were isolated so far from apparently normal sheep and goats.

Regarding the rarer forms of anthroponoses that were studied by them included a case of human respiratory infection due to *pasteurella septica*.

(6) Dr. S. P. Ramakrishnan (Delhi) spoke on the possibility whether malaria constituted a zoonosis transmissible from man to animals or *vice versa*. Citing the instance of successful transmission of *Plasmodium knowlesi* from chimpanzees to man, he stated, that it appeared to be not an important zoonotic problem. Filariasis and toxoplasmosis might possibly be important in that they could be easily passed on to man through such agencies as cats, dogs and pigeons. He ended with a humorous note that there were ones, after all, amongst zoonoses that were beneficant to man i.e. cow pox. As far as filariasis was concerned, he thought that Dr. Raghavan might be able to enlighten the gathering further on this problem.

Dr. Raghavan (Delhi) said that 2 out of 50 cats in Orissa were found to be positive for microfilaria of human type. Until further work was carried out on this problem, he said, possibly one need not bother about this curiosity.

(7) Dr. F. Hawking (National Institute for Medical Research, Mill Hill, London) said that *Filaria malayi* of cats was found to infect man. He opined that pulmonary eosinophilia due to filaria infection in man might be due to some animal filaria or intestinal worms like *Toxocara canis* getting into man as an abnormal host.

(8) Shri M. R. Dhanda (Mukteswar-Kumaon) stressed the important fact that the economically more important zoonoses, bovine tuberculosis, brucellosis, rabies—needed immediate and concerted attention from both medical and public health workers. It should be remembered, he said, that the prevention and control of zoonoses in human beings could be achieved in large part by control of these diseases in animals but not by substitution of post-infection vaccination therapy as in rabies. Practically speaking, the policies of the officials meaning public health programmes in this country should be reorientated in such a way that the problems of mutual importance could be combated by several concerted modes of attack, say, fostering of research for evolution of cheap and highly effective biologicals, institution of epidemiological surveys in newly emerging problems such as were presented by Kyasanur Forest Disease and Q Fever, popular education in the control of rabies and hydatidosis *et cetera*. He said it was not true to say that no work on brucellosis was carried out by veterinarians in India as extensive surveys had already been executed to assess the status of the disease in India and measures for its control and prevention had already been formulated. He mentioned his experience on the incidence of tuberculosis in pigs, cattle, and other animals and pointed out the necessity for more concentrated programmes of research in this field.

Answering a few questions raised by Dr. Ramakrishnan, Dr. Miles contended that there were three distinct phases in any ecological investigation. The first was an arm-chair phase during which known geological, climatological and other data could be assembled of the region to be surveyed. The second was a field survey which should be carried out by a team of workers comprising entomologists, zoologists, botanists etc. with collection teams which could bring material for identification. The third was an etiological and serological survey which was bound to give an idea of the disease potential of any region.

Closing the symposium, the Chairman pointed out the recent developments in many countries in recent years of the establishment of veterinary public health units usually within the organisational frame-work of municipal, district or federal departments of health, to integrate the efforts of veterinary and public health authorities, to act as the bridge connecting the public health and animal husbandry-cum-agriculture resources and interests as well as to serve to synthesise the attack on the various problems of concern to each group. He said that the scope of veterinary public health was broader than that of zoonoses control comprising in addition,

for example, food hygiene. He earnestly hoped that this seminar might have encouraged closer cooperation between veterinary and public health authorities so that accelerated strides could be made in lessening the economic and public health toll exacted by the zoonoses like tuberculosis, brucellosis and rabies.

On a move initiated by Shri Dhanda and supported by the Chairman and the gathering, the following resolution was adopted—

“Resolved that more widely prevalent zoonoses like rabies, brucellosis, bovine tuberculosis should be tackled more effectively by a closer cooperation of medical, public health and veterinary workers in India”.

The following subjects were chosen for symposia to be held at the Bombay meeting in 1960.

- (1) Rabies and its control in India.
- (2) The present status of mycotic infections of man and animals in India.
- (3) Insecticide resistance amongst arthropods of medical and veterinary importance.
- (4) Population control.

II. LABORATORY ANIMALS

Chairman : SHRI P. G. PANDE, Izatnagar.

J. N. TAYAL ((Kanpur) : *Breeding and Maintenance of Laboratory Animals for Biological Standardisation of Drugs, Sera and Vaccines.*

In our laboratory, animals are used for biological standardisation of drugs, sera and vaccines. Dogs and cats are employed mainly for pharmacodynamic studies, while rabbits, guinea pigs, rats and mice are used for *in vivo* and *in vitro* experiments, intended to study the potency as well as freedom from undue toxicity and other side effects of antibiotics, hormones, chemotherapeutic substances, muscle relaxants, local anaesthetics, sera and vaccines. Much difficulty has not been experienced regarding cats and dogs which are procured from local dealers, when very young and brought up under standard and uniform conditions of housing and diet in the animal house of the Laboratory. In order to avoid adverse effects of the hot weather these animals are housed in rooms provided with khas-khas tatties under which condition they thrive well. In rainy season, these animals are protected from showers, while in winter hay is used as bedding in the cages and the animals are kept in closed rooms during night.

As regards the other animals, viz., rabbits, guinea pigs, albino mice and rats, the breeding and maintenance assume especial importance because of the following reasons :—

- (i) Requirement of large number of animals of a homogeneous strain for a single test due to the statistical design of the test method.
- (ii) Non-availability of animals from local dealers or neighbouring institutions.
- (iii) Difficulty of acclimatising animals brought from hilly areas under local conditions.
- (iv) Requirement in regard to the homogeneity of the stock.

From the experience in our laboratory it has been observed that the optimum conditions of temperature and humidity for a majority of the animals are : temperature $80 \pm 5^{\circ}\text{F}$; humidity not exceeding 45%. In the winter season, the temperature goes down and is kept at the optimum level by providing heaters; humidity does not present any problem. In the summer months of May and June, the temperature

inside the rooms shoots up to 105°F, while in July and August, the temperature and humidity are 90°(±5°F) and 75% respectively. The optimum conditions of temperature and humidity mentioned above could be obtained either by providing air conditioning units in the rooms which would bring down the temperature to the required degree without letting the humidity go beyond the optimum requirement. This is very expensive and cannot be normally had in all the rooms of the Animal House. Consequently an alternative cheaper arrangement was the choice; viz., use of dessert coolers. The difficulty in using a dessert cooler has been an increase in humidity to about 80% which is prohibitive. Hence the dessert cooler has to be used in a restricted manner. At night and sometimes in the day also, only dry air has to be pushed into the rooms, which does not solve completely the problem, viz (i) abnormal deaths among the animals during the months of May to July and (ii) decline or sometimes complete cessation of breeding during these months. Even when the breeding takes place the survival of pups is much below the normal. The repercussions of the above two conditions are serious and the problem of getting the required number of animals satisfying the prescribed standards in regard to age, weight and sex, immaturity and virginity, continues throughout the year. Thus if scientific steps are not taken to prevent the loss of the animal colony due to disease and ineffective breeding, the work connected with the biological standardisation (quality control) will be almost at a standstill for about five months in a year and during the remaining period also justice cannot be done to the required design of the test methods. The diseases encountered by us among mice and rabbits have been (a) salmonellosis, (b) pneumonitis and (c) diseases of the intestinal tract, especially in unweaned youngs and (d) coccidiosis. Salmonellosis, coccidiosis and diseases of the intestinal tract were controlled by a strict regimen of hygiene and cleaning. Washing the cages and hutches with 5 per cent solution of lysol or occasional spraying of 2.5 per cent formalin or regular steaming of cages destroys coccidial oocysts and other lung disorders are controlled by sticking to the schedule of intramuscular penicillin administration (mice 10,000 i.u., rats 20,000 i.u., rabbits and guinea pigs 50,000 i.u., 0.2 cc. being administered daily for one week at the first instance, to be repeated if required). Paratyphoid, pneumonia and middle ear disease were encountered in rats. The first one, which is due to *Salmonella* was controlled by immediate isolation and administration of i.m. penicillin to the whole colony. Disease of the middle ear was controlled by complete isolation of the infected animals. Immediate separation of pups after delivery was also resorted to. It took about three or four generations to wipe out the infection.

Other problems connected with the breeding especially of rabbits are (a) losses due to nest mortality and (b) mortality due to fighting among the growing youngs. The former may be attributed partly to the poor health of the lactating does and partly due to their habitual callousness. We observed that selective breeding is very useful for increasing the litter size as well as decreasing nest mortality. The mating is done in a specially designed enclosure under expert supervision. The does that allow themselves to be successfully mated are collected and kept together in a hutch from which they are isolated to individual cages about a week before delivery. Pyogenic infections among rabbits are kept under control by immediate local application of 1 per cent solution of sulphanilamide or mercurochrome.

In the end, it was stressed that by judicious use of penicillin preparations, reinforcing the diet with multivitamin preparations as well as vitamins A & E, standardising the diet and housing conditions (hutches for rabbits), the major problems of breeding and survival of pups of experimental animals were satisfactorily solved. Deaths among experimental animals were brought down, litter sizes improved and could be favourably compared with the results obtained in some of the standard foreign laboratories. The statements were duly supported by charts and tables.

I. RECENT DEVELOPMENTS IN PLANT BREEDING METHODS

Section of Agricultural Sciences

Chairman : DR. B. K. KAR, Calcutta.

1. M. S. SWAMINATHAN (New Delhi) : "*The Role of Radiations in Plant Breeding.*"

Amongst the important recent techniques in plant breeding is the induction of mutations by exposing seeds or different plant parts to X-rays, radio-isotopes, neutrons and other atomic radiations. Some very promising results have already been obtained using this technique both in India and abroad. Mutation breeding may be preferable to hybridization in cases where a specific attribute has to be incorporated in an otherwise desirable strain. This is clear from the performance of the awned and stiff-strawed mutants isolated at the Indian Agricultural Research Institute in some improved rust-resistant Pusa wheat strains. A comparative study of the types and frequencies of mutations induced by different mutagens has also indicated the possibility that it may be possible to control the mutation process experimentally.

Sears (1956) has recently demonstrated an elegant way of transferring a desirable character from one species to another with the help of radiation. By irradiating hybrid plants from a cross of *Triticum aestivum* with the amphidiploid *T. dicoccoides* × *Aegilops umbellulata* followed by backcrosses to *T. aestivum* and rigorous selection, he was able to transfer to bread wheat a small chromosome segment from *Aegilops umbellulata* carrying the gene for resistance to *Puccinia triticina*. A major limitation to the work of plant breeders engaged in distant hybridization in the past has been the lack of any assurance that the desired character will be transferable even after the hybrid has been made. Sears, by bringing about a kind of alteration that might never occur in nature, has paved the way for significant achievements in this field.

Another important use of radiations in plant breeding relates to the diploidization of artificially induced autopolyploids. From detailed studies in induced autopolyploids of several crop plants, it is now evident that coincident with an increase in fertility caused by selection in the autopolyploid, there is a decrease in the frequency of multivalent associations. It therefore follows that the handicap arising from the lowered seed fertility of auto-polyploids can be overcome if a technique to induce functional diploidy in them can be standardised. Radiation induced translocations offer one such method and the results obtained with this method have created fresh hopes with regard to the fruitfulness of polyploidy breeding.

2. Miss K. SULBHA (New Delhi) : *Recent Techniques in species hybridization.*

It is well known that many of the desirable genes which our cultivated crop varieties have lost as a result of intensive selection for yield and culinary characteristics over several centuries, are still present in their wild relatives. Interspecific and intergeneric hybridization have therefore played a very important part in the breeding of new varieties of crop plants and important results have been obtained by this means in wheat, potato, sugarcane, tobacco etc. There are, however, many cross-combinations which are desirable from the breeder's point of view but which cannot be readily made owing to difficulties arising from the premature abortion of the embryo or from other incompatibility barriers such as the inhibition of pollen germination or the inadequate growth of the pollen tube. Techniques are however fortunately available now to overcome these incompatibility barriers.

At the Indian Agricultural Research Institute, some incompatible crosses of interest to the plant breeder have been taken up for detailed investigation. These

are the cross between *Corchorus olitorius* and *C. capsularis* and crosses among *Lycopersicon esculentum*, *L. peruvianum* and *L. glandulosum*. The causes for the failure of seed setting in these crosses have been studied and various techniques have been adopted to obtain viable seeds. These techniques include grafting the concerned species reciprocally and using such plants in making the crosses, using X-rayed pollen, using irradiated plants for crossing and ovule, ovary and embryo culture. The relative utility of these techniques for solving the incompatibility problems will be discussed.

3. S. S. RAJAN (New Delhi): *Polyploidy Breeding—its present state and future prospects*

Nearly two decades have passed since the colchicine method of doubling the chromosome number in plants was standardised and it appears appropriate to take stock of the success of this method as a plant breeding tool and reorientate the present lines of work in the light of experience gained so far.

A survey of induced polyploids which have been successful in agriculture shows that the benefit might accrue in three different ways: the autopolyploids produced might, by themselves, be distinctly superior to their diploid progenitors; or, the fertile polyploids of distant sterile hybrids may be of economic importance; or, in cases of crop species and genera showing a natural polyploid series, the transfer of single valuable character may be possible through artificial polyploidy. To the first group belong, the autotetraploids of grain crops like rye of Sweden and Canada, and *toria* of India, root and forage crops like triploid sugar beet and tetraploid radish of Japan, tetraploid turnips and clovers of Sweden and *berseem* of India and fruit crops like tetraploid grapes and water melon of Japan and ornamental plants like snapdragon, marigold, Forsythia, Iris and orchids. Among these, the last mentioned, because of novel floral and foliage characteristics and forage crops like *berseem* appear to be of immediate economic value, while in others useful results must await long term hybridisation and selection procedures. The production of fertile amphidiploids from sterile hybrids between distant species does not appear to have very bright prospects as shown by the comparative failure of synthesised amphidiploids like *Triticale*. But this method can still be usefully employed in artificially synthesizing natural amphidiploids whose genomic ancestry has been established. Thus, Mizushima produced a fodder type of leafy *Brassica napus*, while Olsson synthesised a tuber-forming artificial *B. napus*. But the greatest significance of induced polyploidy is the overcoming of barriers due to hybrid sterility, in the process of incorporating desirable gene or genes into a well established species. Well known examples are *glutinosa* type of resistance transferred to *N. tabacum* and rust resistance of *Ae. umbellulata* to hexaploid wheat.

While the above are instance of established usefulness of induced polyploidy the significance of some aspects have not been yet fully realized. Hybrid vigour, for instance, can more easily be fixed at tetraploid level than at diploid. Reduction in multivalent formation in tetraploids can be brought about by artificial irradiation and this will be useful in maintaining heterotic vigour due to nonallelic gene interaction. At the tetraploid level the segregation to extremes is reduced while the variance is increased around the mean. These provide valuable breeding material so far as continuously varying characters, particularly in a crop like *toria* in which the yield is the main objective and plant to plant variation is tolerated.

In conclusion, it must be emphasised, that newly produced autopolyploids must be tried out in new environments and areas where the diploids have not been successful before. It is hardly worth the labour to produce an autotetraploid of a single variety. The objective should be to hit on a good combination from as sufficiently large a gene pool as possible assembled at polyploid level. A newly induced poly-

ploid can hardly compete with well-established diploid. Only sustained breeding efforts following induction of polyploidy can bring the best out of it.

4. B. SEN, S. N. SRIVASTAVA and H. C. JOSHI (Almora) : *Recent Development in Plant Breeding Methods.*

Results of extensive research work on genetics indicate that the structures and functions of an organism are controlled by genes. In spite of their great stability through thousands of generations all genes are liable to mutation. These conclusions hold out the possibility for producing "made to order" strains of a crop provided the necessary desirable changes in the structure of the genes and their combination could be made.

By hybridization we effect the migration of genes and from selection of the progenies isolate desired gene combinations. One of the modern methods of plant breeding consists in artificially inducing changes by mutagenic agents e.g. chemicals or ionising radiation.

Ionising radiation is one of the most useful agents for inducing mutation. X-rays, gamma-rays, beta-rays, neutrons fast and slow have been used for inducing mutation. In the early days it was generally believed that the effect of ionising radiation was to produce undesirable mutants but at the first International Conference on Peaceful Uses of Atomic Energy in 1955, workers from many parts of the world presented papers which showed that by choosing appropriate intensities and types of ionising radiation, desirable mutants could be produced.

Working with dormant barley seeds, (Caldecott 1955) was able to show that per unit survival two to four times as many genetic events are produced by thermal neutron irradiation, with their high specific ionisation, than by X-rays. Radiation of dormant seeds has the advantage that large number of seeds can be subjected to the same treatment and large population of plants can be raised from irradiated seeds. Furthermore dormant seeds can be sent long distances for treatment and return. Many possibilities of ionising radiation have been discussed thoroughly at the meetings of the Crops and Soils Wings of the Indian Council of Agricultural Research, held in Simla, in 1956.

In this laboratory we have observed the effect of thermal neutrons radiation on V.L. 13 wheat and on control and vernalised seeds of mustard T. 102. These seeds were sent to Oak Ridge for subjecting them to thermal neutrons irradiation.

X_2 generation of V.L. 13 wheat indicate several mutants types, from unusually large ears with well filled grains to completely sterile ears. There are many dwarf plants and also several albino seedlings. Quite a number of stiff-strawed mutants have been screened. In spite of heavy manuring (100 lbs. of nitrogen per acre) high wind and continuous downpour several lines showed no lodging. Ears of some of the mutants will be exhibited (exhibit 1).

In case of mustard, because vernalised seeds of mustard are not devernalised when dried and stored over 6 years, it was possible to send vernalised seeds to Oak Ridge for thermal neutron irradiation and observe their effects in Almora. It has been found that even irradiation with thermal neutrons did not obliterate in the surviving seedlings the effect induced during vernalisation.

No early mutants could be screened from 1326 progenies of X_2 control seeds but out of 1331 plants from vernalised X_2 seeds 4 early mutants were obtained. The X_2 early plants had yield potential similar to that of T. 102 but their life cycle were significantly shorter and three of these had higher oil content. There was one dwarf mutant with longer life cycle and seeds from this plant were quite different from those of mustard T. 102. The leaves were unusually broad, pods very small with small brown seeds (slide 1).

One of the special facilities which atomic radiation offers is the evolution of new germplasm from which the association of undesirable characters can be broken.

New germplasm thus produced can be incorporated in other strains by the orthodox breeding procedure.

In commercial breeding programme for production of hybrid seeds cytoplasmic male sterile lines are now being very successfully utilised. In the case of hybrid maize seeds, the most expensive item of detasseling can be eliminated and in the case of onions and jowar (Milo) cytoplasmic male sterile lines have made it possible to produce hybrid seeds on a commercial scale.

In this Laboratory hybrid maize seeds without detasseling and hybrid onion and milo seeds without emasculation or sterilization of the flowers are being produced for the past 2 years very successfully.

5. V. SANTHANAM (Madras) : *Recent Developments in Cotton Breeding Methods.*

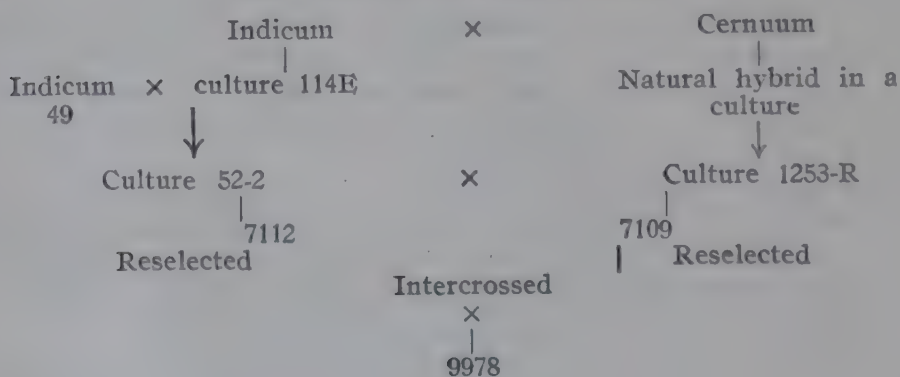
Recent developments in plant breeding methods in Cotton include the "replicated progeny-row" method of Hutchinson and Panse (1937), adoption of "compact family blocks" suggested by Hutchinson and Manning (1943), the "mass-pedigree system of Harland (1949), the "bulked progeny test" of Richmond (1949), and the methods of cumulative or recurrent selection involving certain modifications or adaptations of the backcross and straight hybrid systems or combinations of systems (Richmond, 1949, 1951).

Sikka (1947) has recently emphasised the need for evolving 'flexible' strains of cotton having a 'broad genetic base' so that they may stand up well, in as wide areas as possible, to the hazards and vagaries of the season and has drawn attention to the latter mentioned techniques in this connection.

In the breeding project for the improvement of *arboreum* cotton in the 'Karunganni' tract of Madras State, the results achieved so far, lend support to the techniques underlining the principles of convergent improvement and recurrent selection in evolving long staple strains of cotton combining superior fibre properties. A few strains adaptable for wide environmental diversities have also been evolved under this project.

To illustrate, the parentage of a typical case is presented here and it is suggested that breeding techniques involving adaptations of the recurrent selection technique deserve systematic and wider application in cotton breeding in the future.

Parentage of culture 9978



6. L. M. HUMPHREY : *Use of Atomic Energy in a Soybean Breeding Program.*

The plant breeders' progress depends to a large extent upon the diversity of the material with which he is working. Uniform material showing little diversity will slow progress or perhaps even stop it altogether. To eliminate this situation the breeder has recourse to several procedures. Exploration and introduction of

new types from other geographic locations will introduce a certain amount of diversity. In naturally inbred crops such as the soybean the most widely used method following introduction has been to cross distinctly different types. Much segregation takes place in the early generations, particularly the F_2 and F_3 giving the desired diversity of material from which to select.

In 1948 it was decided to attempt to produce new types through the use of neutron irradiation. The use of irradiation to induce mutations was not new. The use of X-rays and gamma rays had been tried for many years with intermittent success. At the time this work was initiated the use of neutron irradiation had not been tried. It was hoped that the use of a "heavy particle" such as the neutron as contrasted with X- and gamma rays which are light particles, might be more productive.

The material selected for irradiation was seed of a highly uniform strain of Dortchsoy 2 soybeans. This strain had been closely selected for 6 years and since the soybean is naturally inbred this strain had a high degree of purity. This was done in order that any variation found could be attributed to gene mutation presumably induced by the neutron irradiation. Natural mutations are rarely found in soybeans. Two half pound samples of this seed were sealed in pliofilm bags and sent to Oak Ridge, Tennessee, U.S.A. where they were subjected to 1000 r and 1500 r respectively of neutron irradiation by being placed on an atom bomb pile for the required length of time. In 1950 this procedure was repeated but the dosage was increased to 2500 r and 3500 r.

The seed irradiated in 1948 were planted that Spring. No immediate effect from the irradiation was observable. In the second generation a few mutations affecting leaf color were found. These mutations consisted of white, pale green and yellow plants. Only one of the yellows reached maturity and produced seed. It has subsequently bred true.

The seed irradiated in 1950 were planted that Spring. This material differed from that irradiated in 1948 in that there was a marked effect on the first generation. The young plants had a grayish cast, veination of the leaves was very coarse and the leaves were somewhat rugose. As the plant grew the rugoseness remained and the color became very dark green. The plants from seed receiving 2500 r of irradiation matured three weeks later than normal and those from seed receiving 3500 r matured 4 weeks late. There was complete uniformity in these changes in all the plants from the irradiated seed. It seems likely that some change in cytoplasmic structure brought about by the severe neutron irradiation was responsible.

In the second generation 4200 plants were grown from seed harvested in 1950. Two hundred and twenty-eight plants definitely showed mutations in one or more characters. The others appeared normal. The following mutation types appeared :

Leaves—Color

White

Yellow

Virescent

Pale green

Leaves—shape

Heavily rugose

Rugose elongate

Glabrous

Extra leaflets

Pod Characteristics

Yellow color as contrasted with normal dark gray

Increased rate of shattering

Increased shatter resistance.

Plants

Short internode—brachitic
 Med. short internode—semi brachitic
 Long internode—tall
 Increased vigor.

Sterility

Complete sterility
 Partial sterility

Maturity—(Normal is 148 days)

130 days to maturity

140 " " "

160 " " "

180 " " "

Seed characteristics

Reduced size
 Increased size
 Black eye color
 Brown eye color

Bloom color

Purple to white

All of these characteristics were definite and must be attributed to changes induced by the neutron irradiation since the strain originally treated continued to breed absolutely true and showed no off types. A considerable number of the mutants were so reduced in vigor that they failed to survive. Others were sterile and did not produce seed. However, many of the outstanding types not only survived but produced a good supply of seed. These were carried on for seven generations and continued to breed true from the second generation when they first appeared. This would indicate that these characters arose as the result of recessive gene mutations.

The primary purpose of this work was not to produce curiosities but to develop material that could be used in the soybean breeding program in the development of improved varieties. Such things as changes in time of maturity, increased vigor, increased size of seed and increased shatter resistance are all characteristics that could be important in a breeding program. These types were increased and later placed in a variety trials and several of these "atomic" strains proved superior to one or more characteristics. Only one had a yield highly significantly higher than the parent strain. However, this strain also incorporated greatly increased resistance to shatter, increased height and maturity three weeks later than that of the parent strain. This is a combination of characters very desirable in a late maturing soybean variety.

The results of the irradiation experiment indicate that the use of neutron irradiation may be a very useful tool in increasing the diversity of material available to plant breeders and may make possible relatively rapid improvements in varieties of certain crops.

7. U. J. GRANT (New Delhi) : *The Past, Present and Future of Maize Breeding.*

Past

Recent evidence collected in tracing the history of Zeamays indicates that the maize ear has become progressively larger from about the size of a 2-anna piece to more than 1 foot long over the past 5000 years. It would seem unusual for such increase in size to occur by natural selection alone. For this development we are

deeply indebted to ancient civilization in Central or South America—a development vastly more valuable than any modern contribution.

It would seem that there is little more at this time that can profitably be added to the recent history of maize breeding since the accomplishments of over the past 50 years are well known. Maize in the United States in 1953 was planted on 85.5 million acres, averaged 27 maunds per acre and was worth approx. 1588 crores of rupees. 20 per cent of the crop yield can be attributed to the direct utilization of hybrid vigor.

Present

Present day maize breeding is a hard job which requires specialists in many fields of endeavour. It is estimated that only about 50 inbred lines are involved in the majority of hybrid maize seed, commercial or otherwise, sold each year in U.S. These lines are the results of 35 years of intensive breeding work and the effort expended to obtain these 50 outstanding lines has been tremendous.

India is fortunate because three main sources of valuable germplasm can be utilized in a maize improvement program. These are Indian, North American and South American varieties. Exotic inbreds are sometimes hard to produce in India and hybrids from the Northern Corn Belt of the U.S.A. are sometimes dwarfed slightly when planted this far south. However, some of these lines have been used in crosses with local and other material and are extremely promising. Breeding stocks from the medium altitudes of Colombia and other material from the Caribbean region show outstanding promise for India. Yield data for the 10 highest yielding top-cross hybrids compared with two checks at the Tarai State Farm in 1958 are shown in Table. It may be seen from the pedigrees of these crosses that widely diverse material from India, the United States, Colombia, and Peru is involved.

Table 1. The ten highest producing top crosses in 7 maize yield trials, Tarai State Farm, UP, 1958*

Pedigree	Source	Yield Mds./acre	% of Local Check Variety
G 733W-215 x (Wf9 x 38-11)**	USA	80.2	202
G 715-26 x (Wf9 x 38-11)	USA	79.0	199
Dixie 18-1-1-3- - - x (Wf9 x 38-11)	USA	75.3	190
Peru 330-44 x (Wf9 x 38-11)	Peru	74.4	187
G 715-90 x (Wf9 x 38-11)	USA	73.7	186
K.T. 41-15- x (Wf9 x 38-11)	India	72.7	183
P.C.H. -2- - x (Wf9 x 38-11)	India	72.5	183
G 715-211 x (Wf9 x 38-11)	USA	71.3	180
A 26-8- - x (Wf9 x 38-11)	Colombia	71.3	180
G. 733 W-90 x (Wf9 x 38-11)	USA	71.3	180
K.T. 41*** (Check Variety)	India	39.7	100
Texas 26*** (Check Hybrid)	USA	62.0	155

* Data by courtesy of the Maize Breeder, Tarai State Farm, UP.

** A USA single cross utilized as the female parent in many corn belt hybrids, used here as the top-cross tester parent.

*** Average yields of Checks from seven randomized block yield trials.

Some of the later methods of breeding, such as gamete selection and reciprocal recurrent selection, furnish us with certain refinements in selection procedures, but they also burden us with the keeping of detailed records. One factor to be considered in determining selection procedures is the speed with which one wishes to proceed. It requires from 4 to 6 years to complete one cycle of reciprocal recurrent selection, while with early testing top-cross selection the elite materials begin to appear after two or three years. The latter system is being utilized in the Coordinated Maize Breeding Scheme of the Indian Council of Agricultural Research in cooperation with several of the state governments.

The early testing top-cross selection program is, in effect, very simple to handle. The first year the early generation selfed material is top-crossed to a suitable tester. Usually this tester is the parental variety and it is used to determine the general combining ability of the lines. However, as soon as specific combinations (i.e. outstanding single crosses) are available for testers the general combining ability tests are sometimes by-passed in the interests of speed and we begin to look for two lines that combine well with the single cross. We know from the results of maize yield trials in India over the past few years that many exotic single crosses are high yielding and offer excellent possibilities of furnishing one side of a locally developed double cross. This is especially true when flint-dent crosses are made.

The selected top-crosses are tested in yield trials the second season and detailed agronomic and yield data are collected. Simultaneously the lines involved in these top-crosses are planted again in the breeding block and in an isolated top-cross block (usually with a different but sometimes with the same tester) and further selection is practised. This process is repeated and after a number of generations the breeding and testing programme will contain the maximum number of lines that can be handled efficiently.

Elite lines (usually three or more selfs) developed in this manner are advanced into all combination single cross trials and double crosses are predicted from single cross data. Experience has shown that the characteristics are usually fixed well enough after 3 selfs that a line can be recognized and the off types can be rogued from the plots. Selective sibbing is practised in the succeeding generations and considerable vigor can be maintained in the lines in this manner. This is especially important when the breeding lines are subjected to extremely hazardous conditions such as high rainfall, wind, and poor drainage. This system of breeding is quite flexible and the amount of material that can be tested depends largely upon the facilities available. A slight modification in procedure will allow the lines thus developed to be recombined into synthetic varieties. Continuation of this method will give the same results that are expected from other breeding procedures without the necessity of maintaining a detailed record system to take the time of the skilled workers. This does not mean that a complete pedigree system of keeping records can be avoided. Indeed, a breeding programme can never be better than the record system used to record valid, useful and necessary data.

The Future

As previously mentioned, we must know much more about the theoretical aspects of heterosis and combining ability before we can hope to improve our present breeding practices substantially.

The process of developing inbred lines is a long, laborious and expensive one. The doubling of haploids or some similar techniques will possibly be utilized in the future in a practical breeding programme. If an easier way could be found to produce haploids and then double their chromosome number with a high frequency in any breeding stock we choose, the production of inbred lines would be revolutionized.

The use of polyploid maize offers some real possibilities for future improvement of the crop especially in nutritional quality and quantity of certain components of the maize grain. If tetraploids that yield as well as diploids can be developed we can expect their grain to possess more and better nutrients including proteins, oils and vitamins. A modification of selection and breeding procedures may be necessary if polyploids are to be used in order to cope with the masking effects and changes in segregation ratios.

There are good indications that the stalk-ear ratio in maize can be changed drastically. Some of the brachitics and other dwarfs produce a normal sized ear on a plant that is hardly 4 ft. tall. By utilizing this material and making appropriate changes in plant population, it may be possible to raise yields of grain beyond the present limits especially in areas of high heat units and high intensity of sunlight. As a matter of fact the average height of the corn plant has been drastically reduced recently over most of the United States and parts of South America by selection for shorter and more productive types.

A vast amount of maize germplasm has been collected throughout the western hemisphere during the past 15 years. To date only that material which was useful directly in various breeding programmes has been exploited. Screening for disease and insect resistance and other useful characters remains to be accomplished. A gigantic task lies before the maize breeders and other specialists to investigate and properly utilize this breeding material. The Rockefeller Foundation has recognized the potential value of the maize germplasm and has provided the services of an eminent geneticist to help accelerate the evaluation of this material. The work on this important project will get started in the very near future.

There is much talk these days about radio isotopes and other agents that produce mutations. There is not much doubt of the usefulness of such techniques, but until the available germplasm in maize is thoroughly known and exploited, we may be wasting valuable effort, time, and money trying to duplicate something that nature has already provided for us. In fact, we have recently brought seed stocks of a number of varieties to India which will undoubtedly prove to be useful in increasing yields of maize for the cultivators.

There is, naturally, a wide divergence of opinion as to the field where most progress in maize breeding will be made over the next score of years, but in my opinion work to find resistance to pests and diseases should form a large portion of the future programmes. Work on the biochemical and physiological aspects of disease and insect resistance should be accelerated. If only a fraction of the money and facilities that have been used to study human diseases could be applied to basic research to learn why plants are resistant or susceptible to certain diseases, greater progress in this field could be made.

II. CLASSIFICATION AND NOMENCLATURE OF INDIAN SOILS

Chairman : DR. B. K. KAR, Calcutta.

1. S. P. RAYCHAUDHURI (New Delhi) : *Classification and nomenclature of Indian Soils.*

Land is classified for several purposes (1) for scientific knowledge, (2) as an economic inventory of soil resources and (3) as a key to treatment of land to ensure or increase its production potential. Soils of India have so far been classified from the following points of views :—

(i) Soil classification from the geological point of view where soils are grouped according to the geological nature of rocks underlying them.

(ii) Land assessment classification where this system has been mainly used by Settlement Officers and is based on the suitability of the soil for certain crops under local conditions.

(iii) Soil classification from the point of view of properties where it is based mainly on the nutrient status and mechanical composition of surface and subsoils.

(iv) Classification on profile basis where soils are grouped according to the morphological and physicochemical properties of soils. Such studies have been made mainly in connection with irrigation and afforestation projects and in some instances for agronomic purposes.

(v) Pedological classification wherein the soils are grouped on the basis of their origin and development. Some work has been done in our country on this line.

(vi) Soil classification for land use.

The history of soil classification in India starts from the time when land was classified for assessment of revenue and this was based on colour texture and depth of the soil. A scientific approach to the study of Indian soils and their classification was first made by Leather (1898) who distinguished four major soil groups viz., (1) The Indo-Gangetic Alluvium, (2) The Black cotton or Region soils, (3) Red Soils lying on metamorphic rocks and (4) The Laterite soils. Wadia and coworkers (1935) have discussed the relation between the broad soil zones of the country and have concluded that the zones are nearly coterminous with the boundaries of geological outcrops. Much work was not done correlating climate or vegetation with soil formation. Basu (1937) pointed out that the soils of India show certain differences in different zones divided on the basis of Langs' factor. Viswanath and Ukil (1944) prepared a soil map of India, portraying the different climatic types on the basis of N.S. quotients. Based on comparative studies on forty-nine selected soil profiles in India, Viswanath and coworkers (1944) adopted colour and texture as units of classification and these in turn were treated on a background of four major climatic zones viz.; arid, semi-arid, humid and perhumid. Apart from these, few attempts have been made to classify soils of parts of the country.

Genetical soil studies and classification of soils based on morphology, chemical and mineralogical compositions are comparatively recent developments in the country. Sew and Deb (1941) and Raychaudhuri et al (1941, '42, and '44) studied the lateritic and red soils of India and divided them into five categories on the basis of physical, chemical and mineralogical composition down the profile. Mukherjee and Das (1940) in their studies on Kumaon Hill soils in U.P. found four major genetic types viz., forest soils, podsol, red loams and wiesenboden. Basu and Sarin (1938) classified soils of the canal zones of Bombay Deccan into twelve types. Tamhane (1950) concluded that Regurs belonged to the chernozem group. An integrated study of the effect of climate, vegetation and topography on the formation of soil has been made by Raychaudhuri and Mathur (1954) who have divided India into 16 major basic soil regions and 108 minor basic soil regions.

From the above studies, it is possible to recognise the following broad soil groups in India although all these soil groups have not been studied with equal emphasis.

- (i) Red Soils which may be classed as red earth, red loam, yellow earths.
- (ii) Laterite and lateritic soils.
- (iii) Black soils of varying types, including black cotton soil or regur.
- (iv) Alluvial soils.
- (v) Forest and Hill soils.
- (vi) Saline and alkaline soils.
- (vii) Desert soils.
- (viii) Peaty and marshy soils.

A few soil maps of India have been prepared under the auspices of the I.S.S.S. (1932), the Geological Survey of India (1935) and the I.A.R.I. (1943, 1954). The 'Final Report of All India Soil Survey Scheme' (1953) summarise the position regarding soil studies in India till 1945. This is being brought up to date under a new scheme by the I.C.A.R.

A study of the work done in different parts of India indicates the classification of the soils of particular areas. Soil survey was conducted in Kumaon Hills, Bundelkhand tracts and Almora district of U.P. and the soils were classified into four major groups, red loams, brown forest soils, podsoils and weissen boden. From the soil survey of the tarai areas of U.P., the soils were classified mainly on the basis of soil sub family or association in the American model. After extensive work on the soils of U.P., these have been classified on the basis of the predominant soil profile of the particular soil climatic region. Khanna *et al* (1954) have classified the soils of Bihar into (1) non-calcareous, (2) calcareous, (3) heavy clay and (4) Sone alluvium, which have been further sub-divided into classes series type and phases. The soils of Bengal have been classified into Ganga alluvium, Vindhya alluvium, laterites and red soils. Soils of each of these families are further sub-classified and a tentative soil association map prepared. Soil classification of Punjab Plains mainly conducted for pre and post irrigation surveys is based on pH and salt content along the depth of the profile. Soil surveys and classification of river valley projects viz. Chambal project in Rajasthan, Hirakud in Orissa, Mahanadi in Madhya Pradesh, Jungadhadre in Mysore and many other smaller projects have been undertaken. On such studies much stress was laid on the physical and chemical characterisation of the soils profiles. Soil erosion survey and classification on different slope classes were also done in the Hill tracts of south India. The foregoing reveals that survey and nomenclature of soils have been done in the different parts of the country and although attempts have been made to stick on to U.S.D.A. classification, deviations are observed due to lack of uniform description and legend. There is the need that uniform and standardised methods adaptable to country should be evolved and followed. The descriptions of profiles are usually incomplete and morphological terminology is very much loose. So also in genetic classification the study of clay fraction should be given its due prominence.

In mapping soils for general intensive use in addition to the soil map showing types and phases, there should be separate map showing the soil capability grouping and sub-grouping and consists on a detailed scale ($16''=1$ mile or $8''=1$ mile) wherever possible. There will be separately grouping also for other special features like irrigation and reclamation.

2. R. C. HOON (New Delhi) : *Soil Classification and Nomenclature of Indian Soils.*

1. *Introductory* : The attempts at soil classification have been directed mainly to placing them either into 'natural' or 'technical' groups. The former grouping takes into account all the observable characteristics of soil, and such of their relationships as are amenable to comprehension most easily. The latter, on the other hand, underlines relationship of soils to various factors of use and management and, on the basis of one or a few selected characteristics or conditions, for immediate practical objectives for such purposes.

While classification of soil on a uniform basis is very helpful to compare soils in different parts of the world, there is also its utilitarian aspects i.e., it is of help in assessment of land for irrigation development, agronomic use, afforestation etc., and for use of soil as an engineering material.

2. *Factors of Use in Soil Classification* : The five main factors on which classification of soil is generally based are as below :—

- (i) stage of soil development i.e., manifesting the effect of time on such development;
- (ii) differences in the mineralogical or chemical composition of parent material;

- (iii) relations as between relief and soil covering such aspects of the latter as drainage, thickness and/or content of organic matter, degree of differentiation of horizons, salinity, hardpan etc.;
- (iv) influence on soil profile characteristics of such soil forming factors as vegetation, soil microfauna and flora, earth worms etc.;
- (v) contributions to environments due to climate: for instance the north and east faces are comparatively cooler and more moist than the south and west faces.

3. *Soil Characteristic with Reference to its Agricultural use :*

The following soil characteristics are helpful in its classification for agriculture purposes mostly :—

- (i) colour;
- (ii) texture on the basis of main soil constituents;
- (iii) structure i.e., state of aggregation of primary soil particles into clusters due to internal forces mostly;
- (iv) consistency i.e., strength and nature of cohesive and adhesive forces resisting deformation or rupture;
- (v) cementation as brought about by such substances, other than clay, which cause cementing of soil particles;
- (vi) genetic development of profile i.e., sequence of soil material with depth in relation to parent material;
- (vii) state of salinity and/or alkalinity;
- (viii) carbonates content and state of i.e., in form of nodules, hardpan etc., their distribution along profile depth;
- (ix) waterholding capacity;
- (x) permeability;
- (xi) base exchange characteristics.

4. *Land Classification in Relation to Development of Irrigation :*

The classification of land is of very great significance for purpose of its irrigation-cum-agricultural development. Factors, which are of primary and basic importance in land classification are soil, topography and drainage; other factors which are of consideration for the purpose include productive capacity, cost of production, land development and its cost, crop adaptability, climate, quality of water, position and size of area etc.

It is needless to stress that the characteristics of soil of any area are very important for use in land classification, irrigation, productivity-capacity, crop adaptability etc. Soils vary so greatly from place to place that it is difficult to establish types which would be applicable as a guide in determining irrigability of land. Therefore, besides inherent soil factors e.g., soil profile, its mode of formation, depth and degree of modification by weathering, such other soil characteristics as high waterholding capacity, ready penetrability by air and water to ensure their replenishment, slow infiltration rate to prevent excessive losses, adequate depth, amenability to cultural operations, free from harmful accumulation of salts and alkalis, adequate supply of plant nutrients etc., determine the relative suitability of land for development of irrigation and cropping.

Topography and drainage are reactors which modify soil. While topography includes degree of slope, nature of surface relief etc., the drainage factor takes into account the surface and sub-surface drainage characteristics of land, sub-soil water table, its movement, fluctuations and contribution to seepage and the physico-chemical changes expected to result from excessive water. Those attributes of soil in particular and land in general are mainly employed in this country and others to draw out the land classification for purposes of irrigation and cropping.

Soil surveys afford information about the general features of the area and properties of different types of soil not only upto plough-depth but of the sub-soil to a reasonable depth. The data relating to surface and sub-surface drainage conditions and of the depth of water table and its fluctuations during the year throw considerable light on the drainability of soil of any area and have an important bearing on use of irrigation on land. A consideration of variations of such soil characteristics as texture, soluble salt content, pH, etc., seems essential for determining conditions for a rational utilisation of irrigation water and, if need be, for the reclamation of alkali land. It is needless to mention that without the basic information about soil of any area, as is made available from soil survey, the work on essential development of land is hampered to a great extent.

In this country it has been the policy of the Central Water and Power Commission, Ministry of Irrigation and Power and the Irrigation Departments of the States to emphasise carrying out scientific soil surveys of areas to be commanded by the various irrigation development schemes to assess the suitability, or otherwise, of land included for such development. As complete information as possible in that respect about soil and land characteristics of area is given in the project reports in the first instance and in the case of some projects, is periodically assessed during post-project period to study the effect of irrigated cropping.

Based on the characteristic features of soil, topography and drainage, the U.S. Bureau of Reclamation classify land into six categories ranging from first class to the permanently arable land.

5. *Soil Classification for its use as an Engineering Material :*

Although it is not within the scope of the present subject of the symposium, it may be mentioned only briefly that soils, for use as an engineering material, are also classified on the basis of their general characters and physical properties into three major divisions viz., coarse-grained, fine-grained and organic. Those divisions are further sub-divided into eight groups viz., inorganic clays of high, medium or low compressibility, organic clays and organic silts.

6. *Nomenclature of Indian Soils :*

Considerable work on agri-irrigational soil surveys has been carried out in this country during the last three to four decades and the main attempts in the direction of nomenclature of soil, have been to adopt a pattern for classification based on profile studies on lines, more or less, analogous to that followed in some other countries. This is as it should be.

However, from the utilitarian aspect of soil, say for its agri-irrigational potentialities, the soil classification followed in this country is more in terms of differences in their major characteristics than by specific names. In some of the States, however, some local names are adopted to represent soils manifesting particular characteristics; the soil nomenclature thus bears a local brand. As an instance of that localised nomenclature, saline soil is termed 'Kallar' and alkali soil 'Rakkar' in the Punjab and 'Usar' in Uttar Pradesh respectively. There is, thus, still the need of evolving some uniform nomenclature for the different soil types, groups etc., from the point of view of utilisation of land for irrigation and agricultural developments to do away with diversity of terminology followed at present in different States in this country.

3. R. S. MURTHY (New Delhi) : *Morphology and Nomenclature of Alluvial Soils.*

This is a very important subject that has come for discussion when soil surveys are being started in this country on an All India basis. But before starting such surveys it is essential to evolve proper techniques, standardise methods and maintain uniformity in procedure. Soils should be studied from the genetic point of

view with relation to the soil forming factors. For this, profile is the best tool which includes the collection of all the genetic horizons. Horizon differentiations should first be made on the basis of the field characteristics which in turn should be confirmed by the physical, chemical and minerological analysis in the laboratory. Genetical approach to the study of Indian soils is of recent origin in this Institute and it is the object of this note to present some findings obtained from the morphogenesis of some alluvial soils in particular.

There is a general feeling that the alluvial soils are transported materials which have not undergone further development in the process of soil formation. This is partly correct and partly incorrect. To find out what is exactly happening to these soils, investigations have been taken up in a type area between N. latitudes 26 and 28° and E. longitudes 76 and 82° comprising a major portion of the Uttar Pradesh State. Soil profiles are examined with relation to climate and topography. While younger formations show mere stratification, there is profile development going on in the undisturbed older alluvium. Horizon differentiations are made on the following morphological characters (i) colour, (ii) texture and consistency, (iii) Structure, (iv) occurrence of iron mottlings and iron-manganese concretions—their colour, size and abundance, (iv) occurrence of lime concretions, either scattered or forming a horizon by itself. These horizons are first designated in the field by numbers 1, 2, 3 etc. It is seen that the laboratory analysis of the profile samples closely relate to the profile characteristics recorded in the field. pH, Electrical conductivity and clay content gradually increase with depth. Sesquioxides, calcium and magnesium are leached and deposited in the lower layers. That horizon which shows the maximum accumulation of clay, iron and alumina is designated as 'B' horizon and the surface horizon having the maximum organic accumulation is designated as 'A' horizon. A layer of accumulated calcium carbonate which invariably occurs in these soils at lower depths is designated provisionally as C Ca. The question of designating this as a part of the solum in the 'B' horizon is also under consideration. The phenomenon of gleying is also observed in some of these soils where the subsoil water is high and remains in contact with the soil for longer periods. Such horizons are designated as 'G' and are shown as a part of the 'B' horizon. Keeping the above nomenclature as the basis, attempts are being made to draw up a suitable classification for the soils in this region.

4. R. S. MURTHY (New Delhi) : *Classification of Saline and Alkali Soils.*

Salinity-alkalinity hazards have assumed serious proportions in some Indian soils specially in the alluvial tracts of Punjab, Uttar Pradesh and Rajasthan. Such hazards arise mainly due to (i) semi-arid climate, (ii) fluctuating ground water, (iii) local irrigation practices and (iv) bad drainage. These soils can be brought under cultivation only by adopting proper reclamation practices. If reclamation should prove effective, a proper diagnosis of the soils is very essential, which to a great extent is lacking in this country. Salinity alone in a soil is different from either alkalinity alone or salinity alkalinity both combined. The profile morphology is different; the nature and composition of salts in the soil solution are different. The exchange complex is different. Although such soils are called by various local names, there is a need for classifying them into different genetic groups.

Investigations carried out on some saline and alkali soils in the dry as well as irrigated tracts of Uttar Pradesh have shown that they closely resemble the solonchak and solonetz types of soils as described by the Russian workers or the white and black alkali soils as referred to by Hilgard. The saline soils of West Uttar Pradesh, usually Olive brown in colour, are weakly granular; soil pH is about 7.5 in the surface. The Electrical conductivity of twice saturation extracts is very high. Salts are preponderantly chlorides. Profile morphology shows that the salt efflorescence at the surface is underlain by a loose and fluffy layer. These soils are classified

as "Puff Solonchaks". The alkali soils, in addition to being saline, contain high proportions of exchangeable sodium. The carbonate content remains very high at the surface. pH is more than 10 due to the sodium carbonate formation. Part of the organic matter dissolves in sodium hydroxide produced by hydrolysis. Soil is in a fine state of dispersion. Leaching brings about the illuviation of clay which forms a dense subhorizon with a blocky structure. Such soils are classified into solonetz. Investigations on other aspects like origin of calcium carbonate and gypsum, weathering of minerals in the 'B' horizon are in progress. This information will be useful in genetically designating the horizons and modifying the classification wherever needed.

5. T. D. BISWAS and SATRUHAN PRASAD (New Delhi) : *Concept of Catena in the Classification and Nomenclature of Indian Soils.*

An investigation into the genesis of diverse types of soils occurring in close proximity in the Raipur district of Madhya Pradesh has led the authors to suggest the use of catena in the classification and nomenclature of Indian soils. Gist of the results obtained is given below.

Four diverse types of soils, differing widely in their characteristics, are observed in catenary sequence in the Raipur district of Madhya Pradesh and are locally known as *Bhata*, *Matasi*, *Dorsa*, and *Kanhar*. The diversity of soil types occurring in that area is more manifest on slopping topography which itself presents a typical pattern of running from ridge to valley and from valley to ridge. Variation in the colour of surface soils is in harmony with the toposequence in which these soils are found to occur. On one extreme, *Bhata* is a red loamy soil, usually occupying higher of a slope whereas, on the other extreme, *Kanhar* is a deep black soil, mostly confined to the depression at the end of slope. *Matasi* and *Dorsa*, which are respectively yellowish and brownish, occupy the intermediate positions in descending order of topography.

Morphological, physical, and chemical characteristics of the soil profiles follow the same gradation as that of toposequence. Down the slope, the depth of the profile increases, texture improves from loam to heavy clay, structure changes from granular to cloddy, pH changes from acidic to alkaline, the gradation being in the order of *Bhata*, *Matasi*, *Dorsa*, and *Kanhar*. Similar gradation is also found in the chemical composition of the soils. These types of gradational characteristics have been generally classified as a catena. Considering the regular sequence of morphological, chemical, and physical properties of these soils in conformity with the toposequence, and their occurrence in close proximity, it is proposed to term this group of soils as Raipur Catena.

Evidences are there regarding the existence of such types of soils in catenary sequence in many parts of India. The variation in soil types within such small areas presents unsurmountable difficulties in their classification and nomenclature. These difficulties are likely to be obviated if the concept is introduced, wherever possible, in the classification and nomenclature of Indian Soils.

6. AMBIKA SINGH (Lucknow) : *Problems of the Classification of Indian Soils.*

All the pedologists agree that the formation of soils from rocks depends on the nature of the parent material, on climate, vegetation, topography and age, but they disagree on the relative importance of these factors at various 'category levels' in soil classification. Thus, soil taxonomy is yet in a fluid state. Russian and American systems of classification assume, at least at higher 'category levels' that parent material is a blank sheet of paper on which climate and vegetation could write anything, but the experience of pedologists in India, South Africa and South

America is otherwise where the concept of climatic or environmental superiority has not arisen. In India, absolute extremes of climate are encountered yet parent material is dominant in soil differentiation. The Russian and American pedologists had to deal with sedimentary rocks which succumb in proportion to the intensity of the climatic conditions; but here in India the basic igneous rocks have inherent properties which counteract the acidifying and unsaturating effect of climate. Thus, within any particular climate range, particularly in tropics, the classification of soils on the basis of parent material is generally the best and most practical method of classification. Therefore, it is suggested that at the level of 'sub-order' the nature of the parent material must be taken into consideration..

There is another problem in classification of Indian Soils. The parameters of attributes on the basis of which soils of the temperate parts of our globe are classified are too insufficient to fully characterize the soils of the tropics. The soil structure, the soil colour and the textural classes are a few examples amongst other morphological characteristics.

The third problem is the nonuniformity in the methods of soil survey already done, methods of analysis and nomenclature. So it is concluded that :—

1. Russian or American systems of soil classification cannot be followed blindly in India.
2. Parent material must be used as a basis of differentiation at a higher category level.
3. Parameters of the attributes used in differentiation of soil classes need reconsideration.
4. Uniformity in procedure of Soil Survey, methods of analysis and nomenclature must be maintained.

7. S. V. GOVINDA RANJAN (Bangalore) : *Soil Classification and Nomenclature of Indian Soils.*

Survey of soils give a picture of the soils that occur in an area or territory and depending upon the details of study that go into the survey, light is thrown on their genesis, their morphology, their fertility, their drainage conditions and their potentialities for agricultural use. With the increasing tempo of soil survey activities in our Country and the accumulation of a large amount of data and information on the soils that occur in different parts of the Country, the adoption of a rational system of soil classification becomes a necessity. Soils thus surveyed may be grouped in many different ways according to the objectives sought in the classification. Classification can help establish the characters which are interrelated or are common among different groups of soils.

Soil Classification can be based on, (1) taxonomic system where fundamental properties which are related to the genesis of the soils are brought out; (2) the geographical system; or (3) on a system of utilitarian objectives. In the taxonomic system of soil classification the soils are classed according to their morphology and the characters which indicate their most probable genesis. Soils that are closely related taxonomically therefore are not necessarily closely associated geographically. In the geographic system of classification the soils are grouped largely on the basis of their geographic association. They may differ radically one from another in morphology and other factors that would distribute them in widely separated groups in the taxonomic system. The utilitarian system which is largely useful in Land use classification takes into consideration various primary factors like effective soil depth, depth of surface soil and soil permeability into consideration, besides various secondary characters like salinity, alkalinity, presence of organic matter, drainage features and erosion hazards among others. These characters are primarily related to crop production, maintenance of soil fertility and soil conservation and hence this

system of classification would appear to be best suited for our Country where the immediate needs of increasing agricultural production require to be assisted by soil surveys.

III. NUTRITIONAL REQUIREMENTS OF CROPS AND HOW BEST TO MEET THEM

Chairman : DR. B. K. KAR, Calcutta.

1. R. D. ASANA (New Delhi) : *An Appraisal of Plant Analysis Technique.*

Evaluation of nutritional requirements of crops by plant analysis has certain advantages over soil analysis. A nutritional deficiency can be more easily diagnosed and remedied by top or side dressing or by spraying in a growing crop—this holds good particularly in the case of micronutrient deficiencies. Plant analysis further gives an indication of the integrated effect of the absorption of nutrient from the different soil depths to which roots have penetrated. The inadequacies of plant analysis technique must also be taken into account. The ultimate test of the validity of a technique is the degree of correlation obtained between the predicted and the actual value of response to fertilizer application. There does not appear to be substantial experimental evidence on this point. Opinion is also divided on the following points : (i) suitable time of day and stage of development for sampling; (ii) estimation of the form in which a mineral constituent occurs in the plant tissue (e.g., soluble nitrogen, nitrate, soluble calcium etc.); and (iii) on methods of extraction, i.e. by water, acetic acid, hydrochloric acid, ethyl alcohol etc. Allowance is rarely made for variations in the concentration of nutrients other than the one under consideration. Unfavourable weather conditions may affect the standard values of nutritional composition. And finally a positive response to a nutritional spray may be obtained although its deficiency is not detected by tissue analysis.

A survey of the literature reveals that no fool-proof standard plant analysis technique has so far been evolved and it appears as if techniques will have to be standardised for every crop and for every nutrient according to local conditions. The problem in the light of Indian conditions will be discussed.

2 A. R. KHAN (New Delhi) : *Nutritional requirements of crops and how best to meet them.*

Of the three major plant nutrients—nitrogen, phosphorus and potash—the Indian soils have the greatest hunger for nitrogen. In order to understand the reason why in a country like India, where agriculture is practised for over forty centuries, the soils are so much exhausted, a consideration of the condition responsible for it is necessary. Under a hot climate which prevails throughout the year, the organic matter of our soils burns like fuel. Unless it is continuously replenished the land cannot remain in good tune, as is evident from the low yields generally obtained from crops.

It seems necessary to examine the possibility of the use of such plant foods which are cheap and easily available in order to maintain the fertility of land for ever. The major sources of nitrogen may consist of cattle dung, night soil, composts, oil cakes, fertilizers and green manures. In regard to cattle dung two thirds of it is converted into smoke and the third left is so badly stored before use that it loses most of its nutrients. The fate of night soil due to prejudice against it handling by farmers, is worse still. The difficulty in popularising compost may be the scarcity of raw material, labour and water. Oil cakes and fertilizers are good source of nitrogen though they are at present used mostly for cash crops.

Green manuring is, therefore, a cheap and good source of supplying nitrogen to the soil and building up its fertility. In order to draw maximum benefit from

green manuring one should have clear understanding of the technique involved. Those farmers who understand it are successful; others are not.

For the last one decade field experiments are under way in this Institute to develop the technique for green manuring. The results have shown that green manuring is a practice of 'timings'. In case of failure correct timing should be looked into.

3. P. K. SEN (Calcutta): *Plant Nutrition Research.*

Researches in plant nutrition are of fundamental importance for the successful cultivation of crops. Pioneer investigations discovered the constituent elements of plant nutrition and their actions. The plants obtain most of the nutrient elements, except carbon, from the soil. With the necessity of increasing yield with increasing population under conditions of decreasing fertility of agricultural lands due to continuous cultivation, the need for more and more knowledge about the parts played by the nutrient elements are becoming increasingly evident for increasing and maintaining soil fertility. The practice of applying chemical fertilizers to the soil and the growth of fertilizer industries are the results of researches in plant nutrition. The interaction of the various nutrient elements are intricate. For a long time the role of major elements such as N, P, K, were considered to be of utmost importance to agriculture. In recent years, however, it has been found that a deficiency of minor elements such as B, Zn, Cu, Mn, Cl, etc. which are required only in traces can also be responsible for total failure of crops. The subject of plant nutrition deserves much more attention than it has hitherto received for realisation of the maximum benefits of the developing sciences and technologies in fields of chemistry, genetics and plant breeding, soil and irrigation engineering, etc. for increasing agricultural production.

4. A. B. GHOSH (New Delhi): *Nutritional Requirements of Crops and how best to meet them.*

Crops vary in their nutritional requirements. An acre of good paddy takes from the soil about 30-35 lb. N and 20-25 lb. P_2O_5 compared to 80-100 and 100-120 lb. respectively taken by sugarcane. The annual uptake of N, P_2O_5 , K_2O and CaO by major crops in India may be roughly computed at 4.2, 2.1, 7.3 and 4.8 million tons respectively.

There is an acute shortage of organic matter and nitrogen in Indian soils which stands in the way of proper crop growth. Recent studies with radio-active phosphorus (P^{32}) have indicated that about 40-50 per cent of the soils also need phosphate addition. Potash and lime status in most of the soils are good but with intensive cropping they may also become limiting factors in future.

Bulky organic manures maintain high crop yields and also soil fertility as observed in long term trials at Pusa and Coimbatore. They also bring in general improvement in soil conditions. But unless used in large doses they cannot meet the full nutritional demands of crops and India's organic manure resources are not adequate for her needs. Therefore, the National Development Plan aims at increasing the production and use of nitrogenous and phosphatic fertilizers for supplying plant nutrients to country's agricultural lands. Their prolonged use may, however, lead to some physiological imbalance in soil which can largely be counteracted by using organic matter.

The best possible way for meeting the nutritional requirements of crops in India is to use chemical fertilizers in suitable doses over a basal manuring of bulky organic manures. As nitrogen maintains a steady relationship with soil humus hence the addition of nitrogenous chemicals alone in large doses without any organic

supplement results in a loss of plant food. Availability of other mineral nutrients is adversely affected in the absence of sufficient amount of soil organic matter.

Green manuring supplies carbon and nitrogen and also improves nutrient supplying power in soils. Special mention may be made of the outstanding result observed in the Pusa experiments where green manure (sannhemp) is raised with superphosphate and this treatment gives better yields of succeeding cereals than those obtained with heavy dose of F.Y.M. Phosphate manuring of legumes, like clover, not only results in their increased yields but the soils also are in a better position to supply nutrients to crops following them.

An efficient manure and fertilizer use programme for meeting the nutritional requirements of crops should also keep in view irrigation and management practices because under unfavourable conditions plants are not able to utilize nutrients even if soils supply them in adequate amounts.

5 C. T. ABICHANDANI (Cuttack) : *Rationalization of Fertilizer Application to Rice for increasing Acre Yields.*

The success of application of nitrogenous fertilizer to rice depends on nitrogen level, time and method of application. *Indica* varieties of rice, grown in our country, do not respond to high degree of manuring as the *japonica* varieties do. The nitrogen metabolism of *indica* varieties gets disturbed at the reproductive stage, if it is grown at a high manuring level, and the grain yield is pulled down.

Nitrogen level, needed for increasing rice yields, depends on inherent soil fertility, soil drainage and soil-water pattern etc., during the growth period of the crop. 40-60 kg/ha is generally accepted as nitrogen level for optimum rice yields. The efficiency of this fertilization depends on the time and method of application.

Rice plant shows two period of vigorous nitrogen uptake; the first period occurs during the vegetative phase, starts about ten to fifteen days after planting and ends with the maximum tillering stage. The second period occurs during the reproductive phase, commences with ear-initiation and lasts till grain setting is complete. The first stage helps in increasing tiller number per plant and the second increases the ear weight of the plant. Adequate nitrogen in the soil is therefore essential during these two stages of growth.

Under field conditions in wet rice soils, surface run off, leaching and denitrification bring about losses of fertilizer nitrogen. Nitrogen, applied at early stages of growth, is therefore not equally effective, as above factors, sooner or later, deplete the soil of fertilizer nitrogen and need for second application will therefore arise at the reproductive stage. Split application of fertilizer, part basal at planting and part at ear-initiation stage is therefore a rational practice for increasing rice yields. By adopting this practice, rice yields can be increased by 6-8 per cent.

Rice varieties differ in their process of nitrogen uptake. In early duration varieties, ear-initiation follows closely the maximum tillering stage; the nitrogen absorption in these varieties is therefore a continuous process. In the late duration varieties, there is a time lag between the two peak periods of nitrogen uptake. Late duration varieties are therefore likely to benefit more from split application than early duration varieties. High level of nitrogen application at ear-initiation stage is to be avoided as this disturbs nitrogen metabolism of the plant and pulls down grain yield.

Fertilizer efficiency can also be increased by checking nitrogen losses from the soil due to surface run off, leaching and denitrification. This can be done successfully by placing the ammonium fertilizer deep in the sub-surface zone of the wet soil. By this method, ammonium fertilizer gets deep distributed in the soil and remains comparatively stable in the reduced sub-surface zone. About 2-20 cm. is considered as strongly reduced zone of the rice soil. In this zone, pH drops to about 100 mv, and here nitrate gets denitrified and loses its fertility value. In the

top surface, pH is higher than 350-400 mv.; here ammonium nitrogen gets converted to nitrate nitrogen which subsequently gets denitrified, when leached down to lower depths. Sub-surface placement of ammonium fertilizer is therefore a rational method of application for increasing fertilizer response. Adoption of this method increases fertilizer efficiency nearly two fold and in experiments conducted over last 6-8 years, 8-10 per cent increase in grain yield has been obtained over customary surface application.

It has been seen that by combination of these factors, the time and method of application, fertilizer efficiency can be increased and acre yields pushed up by 15-20 per cent over the customary practice of fertilization.

6. AMBIKA SINGH (Lucknow) : *Precise Determination of the Nutrient Requirement of Crops and Rational Use of Fertilizer for them.*

The determination of the nutrient requirement of a crop is not so simple as it seems on the first glance that a particular crop needs so many pounds of a plant nutrient, the soil that sustains it contains so many pounds of the nutrient and, therefore, the balance must be supplied in the form of fertilizer.

Out of fifteen elements now considered essential for crop plants, some twelve cross the boundary between soil and plant by some multiplicity of processes. Every element has its own diverse history in the soil and its fate in the plant. Thus an assessment of the nutrient requirement of crop will have to be based on :—

(1) The ability of the soil system to provide a concentration (or 'intensity level' more precisely 'Chemical Potential') of the nutrient in its solution phase to the roots. This 'Chemical potential' depends on so many things like total amount and form of the nutrient, presence or absence of other elements, pH and physical conditions of the soil. This is a dynamic process and not an equilibrium state.

(2) The absorption of the nutrient ions by the plant through its roots.

If the distributions of the roots and nutrient ion in the soil are not uniform, the geometry of their distribution also becomes important.

It is obvious from the above discussion that this question encompasses the domain of soil chemistry, soil fertility, fertilizer usage and plant nutrition. Thus the precise determination will be based on :—

(i) Soil Survey to classify soils with respect to their management needs and crop adaptability.

(ii) A study of the rate and ease of the transformation of the nutrient element from one category of availability to the other and how it is affected by management practices required to raise the crop. The fate of the added fertilizer should also be studied on soil type basis.

(iii) Working out the total amount of nutrient required to raise crop for optimum yield with desirable quality.

4. Routine soil testing for pH and available phosphorous and potassium and in special cases for minor elements.

In the background of these informations, the field experiments will furnish precise data on the fertilizer requirement of the crop. The field experiments must be conducted taking soil type as unit in a particular ecological habitat of the crop. Tissue testing either to assess the current nutrient need of the crop or the nutritional survey of the area will also be very useful.

It is also pointed out here that many problems will not be solved by conventional methods. The tractor technique will help to solve those problems.

7. B. K. KAR (Barrackpore) : *Nutritional requirements of crops and how best to meet them—a consideration from Physiological Aspect.*

Nutritional requirement of a crop is essentially dependent upon the physiological processes, which lead to vegetative growth, and development into reproductive

phases of flowering and seed formation. A certain amount of growth is necessary in order to enable the plant to develop into the latter phases. In grain crops, the developmental phases are of importance to produce the seeds or grains, while in bast fibre crops the vegetative phase is more important, for the fibre is produced in this phase. In general the nutritional requirement of a crop is to be judged on the effect produced by various manurial treatments on the sequence of these physiological changes. One of the practical methods followed in agricultural practices is by means of manurial trials with various levels of nutrients (organic and inorganic) and their combinations, together with other factors like varieties, spacings, and different sowing dates. Here the success or otherwise of the experiment is judged by the end product, which is no doubt the most important, but more profitable results could be obtained if such trials are supplemented by investigations on the response of the plants to different treatments. The reactions of the plant leading upto the harvest time should, therefore, be thoroughly investigated and understood.

This can easily be implemented by pot-culture experiments, where the nutritional requirements may well be investigated from the above point of view, under controlled conditions. All manurial or agronomical trials should be preceded by such controlled pilot experiments, and data obtained. To understand intricate interactions of different nutrients or trace elements, sand culture experiments are important; but for practical purpose, pot-culture with soil as media, is to be preferred because it replicates the field conditions and at the same time is controllable for specific purpose. It provides more or less uniform plant material for sampling and chemical estimation of uptake of nutrients, at different phases of growth. Root-growth study, can also be suitably studied in these experiments. It is needless to mention here, that pot-culture experiments have provided us with valuable and fundamental results.

In order, therefore, to know the nutritional requirement of a crop, it is imperative to subject the crop to series of intensive pot-culture treatments and the results thus obtained should be utilized and verified in its turn, for field trials. Through this coordinated scheme of investigation, a surer basis for understanding the plant and its requirements could be evolved, eliminating the factor of chance to a great extent.

Jute, for example, which is economically important for the vigour of its vegetative growth, has yielded valuable results when subjected to different pot-culture experiments. The growth and nature of root-system and absorption of different nutrients which are applied at different phases of growth, have been correlated with the absorption efficiency of the plants. The differences, shown to response of ammonical and nitrate nitrogen treatments in increasing the gross output of green matter, in contrast to changes brought about in the corresponding values of fibre-percentage, have been brought out. The yield of fibre in jute is dependent upon the variations of many growth components as green weight, dry weight, bark weight, wood weight and fibre weight. The fibre itself is a heterogenous material with reference to age, maturity and chemical composition. All these could profitably be studied under controlled cultural conditions, where factors of variation could be reduced, and comparable results obtained.

Every crop has its own characteristics as to nutritional adaptability, and the physiological processes involved therein, should therefore, be properly investigated, to know the nutritional requirements and then to meet them through recommended agricultural operations.

8. J. K. CHOUDHURY (Calcutta) : *Some aspects of water and nitrogen in relation to plant nutrition.*

Indian agricultural production can be considerably increased if two things are provided in required quantity and at proper time, viz. water and nitrogen. Most crops require an excess of water only at two or three stages of their growth, —

during germination, at transplanting and at the early growing period (in the phase of elongation). Excessive irrigation in the reproductive stage often reduce the yield, as is the case in grain of cereals (grain to straw ratio).

Our agriculture suffers from chronic scarcity of water with occasional flood, both of which cause enormous damage to the crops. Such a loss due to flood is not confined only to the field crops but also extend to trees (particularly fruit trees) whose root system is affected either by inundation or by the soil-water level rising too high.

Elements are absorbed by plants from a very dilute solution present in the medium in which they grow, e.g. to total nitrogen in tropical soil constitutes about 0.05%, of which 10-30% remain in an available form. In cropped fields nitrogen level naturally falls low and replenishing of nitrogen stock of such fields is being increasingly done with fertilisers, such as Ammonium sulphate, a heavy dose of which is known to enormously benefit some crops, e.g. jute, rice etc. But fertilisers like Ammonium sulphate, unlike organic manures, has little residual effect and by repeated use turns the soil acidic. Moreover, India does not produce enough Ammonium sulphate for her cultivated lands. For these reasons it appears that a mixed manurial practice (containing inorganic and organic manures) would be a better approach to meet our agricultural requirement in this respect.

It would be useful if a review of the work done hitherto on crop nutrition in India and the methods successfully employed for the purpose was prepared and published. This will provide an incentive and a guidance for future investigation on this problem of our agriculture.

IV. RECENT DEVELOPMENT IN PLANT DISEASES AND PEST CONTROL

Chairman : DR. B. K. KAR, Calcutta.

1. R. NARAYANAN, A. R. S. KARTHA and K. C. GULATI (New Delhi) : *Some observations on the Development of Pest control chemicals (Insecto-Fungicides).*

Annual crop losses inflicted today by pests in United States of America, during any normal year, according to conservative estimates are figured at roughly 11 billion in spite of substantial use of pesticides. Of this loss about 3 billion is caused annually by insects, 3 billion by fungi and plant diseases and 5 billion by weeds. In India, the rice crop alone due to combined onslaught of diseases and pest suffers an annual loss of about 20% of our total production, amounting approximately to about 5 million tons, valued nearly at Rs. 500 crores. In epidemic outbreaks losses to the extent of 60% in yield occur, causing near famine conditions in the affected regions. Besides, increasing irrigation facilities as are now coming up in the country might create situation still more favourable to the unimpeded march of agricultural pests. In an under-developed country like India, control of crop pests means more food and greater prosperity.

Perhaps, a new compound that in a single chemical combines insecticidal and fungicidal properties, may in part be the answer. Study of chemical literature, in this respect, pins down the choice to organic thiocyanates as one of the most important probable groups for the development of insecto-fungicides.

Thiocyanates as insecticides were first patented in 1930. Some of them are now among the well known commercial insecticides. The thiocyanates in certain respects resemble pyrethrins in causing rapid knock-down and paralysis of active insects. The thiocyanates contain in them N.C.S. group of the dithio-carbamates and so should be possessed of fungi toxic properties. The thiocyanates, possibly need a second electronegative group in the molecule to make them effective fungicides.

Compounds like longifolyl thiocyanacetate, (I) nopyl thiocyanacetate, (II) isobornyl thiocyanacetate, (III) longifolene dithiocyanate, (IV) and glyceryl dithiocyanacetate, (V) based upon indigenous raw materials, have been synthesized and tested for insecticidal and fungicidal properties. Compounds (I), (II) and (III) have shown promising properties as insecticides against mustard aphids, *Lipaphis erysimi*, but do not seem to possess any fungicidal properties, (I) has even been tried on semi field scale on mustard crop with success and has shown no phyto-toxicity. (I) at 50 mg./sq. ft. on glass surface seems to have residual toxicity against *Culex fatigans* and *Musca nobilo* for about five weeks and compares favourably with DDT at this level, when tested under similar conditions. At lower dosages of 12.5—25 mg./sq. ft., the insecticidal effect was not appreciable. The three chemicals also exhibit slight synergism for pyrethrins (IV) showed itself as weak insecticide against aphids and is still to be tested for its fungicidal activity, whereas, (V) possessed good fungicidal properties and inhibited the germination of *Alternaria tenuis* spores at 0.1% concentration, but failed to show any significant insecticidal property, against aphids and *Tribolium castaneum* as contact poison or against 5th stage locust hoppers as stomach poison.

It may be very difficult to make any predictions into the full range of potentialities of organic thiocyanates as insecto-fungicides, however, the present indications do point out the fact that thiocyanates will have to be tailored and the toxophoric group/groups so arranged in the molecules that they develop a proper shape so as to penetrate the insect cuticle as well as fungus cell membrane and thus bring about dislocation in the metabolic processes of both.

Research in the field requires the skill of the specialists including chemists, entomologists, plant pathologists, plant physiologists and even agricultural engineers and medical men. With a view to establish a chemical as an effective pesticide, the research and development work has to be highly collaborative, comprehensive and highly detailed, which inspite of all this, may often time turns out to be hopelessly unrewarding. Even this much, would not have been possible to report but for the active collaboration among the various research workers from within the different Divisions of the Institute and outside organisation like Malaria Institute of India.

Some of the details of the work, carried out on collaborative basis, will be reported at the time of the symposium.

2. R. S. DEWAN and K. C. GULATI (New Delhi): *Pesticides from Indian Turpentine Oil.*

Pesticides comprise of insecticides, fungicides, weedicides and rodenticides, the latest wrinkle in the field being the antibiotics. Production of these chemicals, to a very large extent, is based on the reactive hydrocarbons derived either from petroleum, carbonisation of coal, calcium carbide or the terpenes from turpentine oil.

India offers abundant and perennial supplies of turpentine oil, ex *Pinus longifolia*, which consists of 20 to 30% pinenes 40 to 60% carenes and 10 to 15% a sesquiterpene longifolene. Carenes which constitute a major part of the oil bear some similarity of structure to a part of the molecule of pyrethroids-established insecticides. Terpenes as a class are also known to bring about narcosis by penetrating through the nerve parts.

Attempts have been made at the Indian Agricultural Research Institute to convert these terpenes through processes of hydroxylation, etherification and esterification, etc. into alcohols, ethers and esters. The investigations relating to the preparation of terpene ethers, alcohols, thiocyanates, organophosphorus and organomercurial derivatives have been reported elsewhere.

The trichloro methane group (CCl_3) is a well known toxophore. The same has been tagged on to terpenes by forming adduct with carbontetrachloride in case of

carenes and longifolene as well as through the formation of trichloroacetates from isobornyl, nopyl and longifolyl alcohols. The trichloroacetates when tested against *C. cephalonica*, *Tribolium castaneum*, *Trogoderma granarium* and *Rhopalosiphum pseudobrassica*, showed mild insecticidal activity.

In case of chlorinated insecticides, besides factors such as the molecular density of the compound and the rate of its dehydrochlorination at the site of action, the activity also depends upon the level of chlorine in the molecule. With this end in view the trichloroacetates which already contain the toxophere— CCl_3 , are being processed further to introduce polyhalogen groups. Results of investigations will be reported at the symposium.

3 S. PRADHAN (New Delhi) : *Some Problems arising out of recent Developments in Plant Diseases and Pest Control.*

The intention is to discuss the following seven problems which have important scientific and commercial implications :—

1. *Health hazards involved in the use of insecticides :*

This question has been agitating the minds of scientists and administrators alike. Hence this question requires thorough discussion specially from three main angles :—

- (a) The possibility of immediate acute poisoning.
- (b) The potentialities for cumulative action leading (i) to chronic toxicity and (ii) to acute toxicity at some later date.
- (c) The possibilities of acute or/and chronic toxicity to babies although the mother may not feel any ill effects.

2. *Evolution of insect strains resistant to insecticides :*

This problem has become so serious for the entomologists of the public health departments that the World Health Organisation recently held an international seminar in Delhi. Hence agricultural entomologists have to clearly understand it and avoid it if possible or at least be prepared to face it. A very careful consideration of the various angles of this question is likely to reveal a very interesting probability that the evolution of resistant strains may actually be an index of or a certificate for almost a thorough job done by the control operators concerned.

3. *Trial of insecticides the chemical composition of which is not known :*

Despite all the difficulties pointed out in various quarters, some committees have rightly come to the conclusion that it is neither in the interest of science nor in the long range interest of the industry to carry out scientific trials and publish results on formulations, the chemical composition of which are not declared. In fact it is not enough to declare only the active ingredient as demanded by the Cotton Committee, for example, because there are a large number of ready-to-use formulations with the same active ingredient and different types of accessories which at times make very material difference in the final performance.

4. *Trial of insecticides with trade names :*

Even declaration of chemical constituents is not enough if the formulation is being sold under a trade name. It is extremely important that no trade names are used in any recommendation or publication because the manufacturers are always at liberty to change the composition of the formulation without changing the trade name. As and when the manufacturer introduces any change, and that too without notice to the public, all publications and recommendations based on that trade name become worse than useless. In some countries it is a practice that the manufacturer gives up his trade right over the name which he declares as a common name and then that name is used in publications and recommendations.

5. Issue of reports on samples received from firms :

What is to be appreciated is that a sample received from any firm is not to be confused with statistically unbiased samples with which scientists are generally familiar. Hence it is against the long range interest of the country and the industry for government departments and other institutions of repute to issue reports on samples received from firms unless a strict provision has been made that the report is to be used only for improving the formulations and not for any commercial propaganda.

6. Standard specifications for insecticides :

During recent years there has been much talk about laying down standard specifications for different insecticides. Generally speaking it is a very desirable move but there is a tendency often to forget what is known as specificity of insecticides. One insecticide or one formulation of the same insecticide may be very effective against one species of insect and the same may be practically useless against another species. For example such an important insecticide as DDT is so ineffective against locust (*Schistocerca gregaria*) that it can hardly be called an insecticide with reference to this species. Thus it is unscientific to lay down specifications for any insecticide except with definite reference to one or a few insects against which that specification has been experimentally found to be useful. That is why W.H.O. which is interested mainly with malaria carrying mosquitoes and a few other species has prepared specification of some insecticides useful against these few species but F.A.O. which is interested in scores of species could not prepare specifications. Thus it should be appreciated that the question of standardisation of specifications of insecticides is desirable only with reference to definite species of pests such as locust for which it is so economical to manufacture specific formulation because of the large quantities required for a single species, but even in these cases the standardisation has to be based on actual experimentation with that particular species and not on mere discussion and compromise across the table without any experimental basis as it is sometimes done. At any rate it is highly unscientific to make the so-called standard specification without specifying definitely the purpose for which those specifications are supposed to be meant.

7. Periodic check of the quantity of insecticides supplied at various levels up to consumers level :

In countries which are admittedly advanced so far as the use of pesticides is concerned there exist some sort of organisation to check the sale of spurious material of inferior qualities. In U.S.A. there is the Federal Insecticide, Fungicide and Rodenticide act while in Britain there is a scheme for official approval of proprietary insecticides. In India there has been nothing of this kind till recently when a unit for Biological Testing and Certification of Insecticides has been created in the Entomology Division of I.A.R.I. as one of the activities of the Second Five-Year Plan. The functions of this unit constitute (i) Periodic survey of the quality of insecticide supplied to various levels, (ii) Bioassay of relative toxicity of various insecticides and their ready-to-use formulations against each important pest separately and (iii) Testing the efficacy of samples received from various government departments and firms on payment basis. The testing of samples from firms has to be undertaken under definite understanding that the report will be used only for improving the formulation and not for propaganda purposes.

4. R. N. TANDON (Allahabad) : Control measures against some fungi causing certain diseases of plants of economic importance.

The control measures against certain fungi causing the following diseases have been studied :—

- (i) Anthracnose of (a) guava caused by *Gloeosporium psidii*, (b) Citrus caused

by *G. citricolum*, (c) lime caused by *G. limotticolum*, and (d) papaya caused by *G. papaya*, (ii) Leaf spot disease of (a) *Cycas revoluta* caused by *Phyllosticta cycadina*, (b) *Artocarpus integrifolia* caused by *P. artocarpina*, (c) *Eucalyptus robusta* caused by *Phyllosticta* sp., (d) *Mangifera indica* caused by *Pestalotia mangiferae*, (e) tea caused by *P. theae*, and (f) *Livistona rotandifolia* caused by *Pestalotia* sp. and (g) *Mimusops elangi* caused by *Pestalotia* sp. (iii) Fruit rot of (a) apples—*Alternaria tenuis*, *Aspergillus terrus*, *Pestalotia malorum*, (b) banana *Gloeosporium musarum*, (c) guava *Pestalotia psidii*, (d) pineapple *Alternaria* sp., (e) lemon *Fusarium* sp. (iv) Dry rot of *Colocasia antiquorum* *Fusarium coeruleum*.

As numerous proprietary fungicides are now available, it becomes difficult and unnecessary to test a large number of them under the field conditions. This is, therefore, desirable to carry out laboratory evaluation of different fungicides before applying them for large scale field work. For this purpose the technique suggested by Fosberg (1949), for evaluating fungicides in laboratory has been followed. This gives a clear idea about the inhibiting effects of various fungicides on different organisms responsible for various types of diseases. The spore resistance method for the evaluation of fungicides was also tested. This method of evaluating protectant fungicides in laboratory by means of spore inhibiting ability of different fungicides has been recommended by Horsefall *et al* (1940),² Simmonds (1940)³ and Mc Callam and Wellman (1942)⁴.

In all the efficiency of the following 16 fungicides was evaluated in the laboratory :

1. Perenox, 2. Agrosan G. N., 3. Spergon, 4. Ceresan, 5. Zerlate, 6. Diathane Z-78, 7. Tillex, 8. Copper sandoz, 9. Cuprovit, 10. Phygon, 11. Bordeaux mixture, 12. Isothan Q-15, 13. U.N.R. 50%, 14. Dowicide A, 15. Ridsaon, 16. B Zinc sulphate.

The effective fungicides against particular organisms are recorded.

Large scale trials under different storage conditions for fruit rots or in the fields for other diseases were carried out. It was found that the losses were prevented or greatly reduced by the application of effective fungicides but fungicide which checked the growth of an organism in laboratory did not always control the disease under field conditions. Isothan 0.3% which checked the growth of *Gloeosporium psidii* and *G. limetticolum* in laboratory could not control the disease under field conditions. Similarly 0.2% tillex and 0.2% copper sandoz which inhibited the growth of *Phyllosticta artocarpina* in laboratory were not very effective under field condition. Similar behaviour was exhibited by various other organisms also.

Besides use of fungicides it was also observed that the intensity and wave length of light may determine the spread of certain diseases. It was observed that the rot of apples caused by *Alternaria tenuis* was greatly reduced when the fruits were exposed to red or blue light. Similarly the soft rot of apples caused by *Pestalotia malorum* could also be reduced in red, or orange light. Thus losses caused by these fungi could be prevented either by wrapping the fruits in papers of particular colour or by illuminating the store house with red, blue or orange light as the case may be.

It was, however, observed that the light of particular wave length did not have the same effect on all organisms.

Control measures have been suggested for the diseases under study.

5. S. V. RAJAN (Coorg, Mysore State) : "Recent Development in Plant and Pest Control".

In man's never ending struggle against the insect pests, the chemical control of the insects has come to play the most important role. Today more than 100,000 organic chemicals are at our disposal as potential insecticides, and more than 100 are in commercial use.

Making an humble beginning in the use of crude tobacco extraction against aphids in 1763, several chemicals have been in use, like Nicotine, Nicotine Sulphate, Rotenone, Pyrethrum, Derris, Arsenicals, Flourine compounds, organic thiocyanates, phenothiazine, Azobenzene, Dinitro derivatives of phenol and cresols, organic synthetic compounds like DDT, DDD, BHC, and chlorinated hydrocarbons like Toxaphene, Chlorodane, Aldrin, Dieldrin, Endrin, and so on. In spite of this rapid and extensive use of chemicals, much remains to be learned regarding the chemistry, mode of action of the insecticides, the interrelation between the chemical structure and their mode of action and metabolism in insects and their toxic hazards to man and other mammals.

More recently a number of phosphorous insecticides like HETP, TEPP, Parathion and Octamethyl pyrophosphate anide, have come to play an important role in pest control. HETP and TEPP have found ready use as aphicides and as they break down immediately after spraying, and effectively killing the pests; they are becoming more popular in controlling pest of edible crops. Parathion is a more potent, long lasting chemical, very effective at extremely low doses against wide range of insects. In spite of their high toxicity to man and other mammals, these phosphorous insecticides are gaining importance. Of late, a new class of insecticides known as systemic insecticides has been developed in Germany and Britain. They are chiefly complex organic phosphorous and flourine compounds. Chemical compounds like Systox, Metasystox, Isopestox, Pestox are the popular ones in the market. These systemic insecticides are absorbed by the roots, when applied to soil, or through the foliage when sprayed, and transported by the cell sap throughout the plant tissue, which is rendered toxic to insects, without any effect on plants themselves. These are highly selective and quick in action, against sucking, biting and chewing, insect pests. They are highly toxic to man and other mammals.

In spite of their toxic hazard, the systemic insecticides have captured the imagination of Entomologists all over the world, and are fast becoming popular in America and other Western countries since 1951. It may be safely said that the use and application of systemic insecticides, is the most recent development in the pest control. By properly integrating the use of systemic insecticides, with the biological and chemical control, the long sought problem of insect pest control is nearing its solution. However, much more research is necessary regarding their practical application and usefulness in plant protection.

With the advent of these new and powerful insecticides, today there is a greater necessity of laying much stress on the detailed study of the Biology of insect pests, and several environmental factors (both climatic and biotic) that affect them, either favourably or unfavourably. A detailed investigation of the natural enemies of insect pests, like predators, parasites, parasitic microbes, and viruses, and their biology is of primary importance, besides a thorough study and understanding of the influence of the climatic factors on these natural enemies. Thus the problem of insect pest control becomes much more intricate and vast, which needs to be mastered.

In conclusion, it may be stated that, presently we are required to work more with the nature than against her, in introducing these new insecticides. By adopting these steps, we can hopefully look forward for the day, to solve the pestering problem of the Insect pest control successfully.

6. S. Y. PADMANABHAN (Cuttack) : *Recent development in plant disease and pest control with special reference to control of Rice Diseases.*

. Recent developments on control of rice diseases have been in the direction of evolution of resistant varieties, control of disease outbreaks through direct fungicidal sprays linked with forecasting techniques, chemotherapy with antifungal antibiotics,

and through adjustment of agronomic or cultural practices. Attempts being made to understand the nature of disease resistance may throw up further effective tools to minimise the loss caused by the diseases.

In the case of blast disease, which is the most destructive disease of rice, intensive search for resistant genes in both cultivated and wild rices is in progress; hybridization programmes are underway, some of which have resulted in the successful evolution of highly resistant rice varieties possessing high yielding character. Advances have been made in direct control through fungicidal sprays. Economic spray schedules with low volume sprayings have been worked and effective control of blast through the use of both copper based fungicides and organo mercurials have been demonstrated. Forecasting techniques based upon the number of spores in the air at different stages of crop development as well those that are based upon precise correlations between prevailing weather factors and blast epidemics have been developed, notably in Japan.

An understanding of the factors influencing disease development has led to the formulation of suggestions involving slight adjustments of agronomic practices to minimise the chances of disease development.

Direct control through seed treatment with organomercurial fungicides have been successfully adopted to control foot rot disease of rice. Control of helminthosporium through development of resistant varieties has been attempted. Work is in progress to understand the conditions of development of stem-rot epidemics. Physiological disease of rice due to upsets which retard root development has also received considerable attention.

7. T. SREERAMULU (Waltair): *Recent developments in the study of Air-borne Plant Diseases and their importance in evolving Control Measures.*

As the spread of an air-borne fungus disease in the field is controlled by many biological and physical factors which operate at many points in the disease cycle, for evolving effective control measures a knowledge of the relative importance of the various factors at different stages in the disease cycle is essential. The magnitude of the possible factors or the interaction of some of these factors which probably control the epidemiology of a particular air-borne fungus disease can be usefully examined by using some of the new techniques developed during the last 10 years. How the information gathered employing these modern methods (1. Air sampling by employing more efficient volumetric suction traps to estimate the amount of inoculum available in the field; 2. better field recording by taking simultaneous observations on the growth stage of the host, the infection stage of the parasite and the effect of weather conditions on both; and 3. the methods evolved for understanding plant disease gradients and for developing laws of dispersal of spores in the air to estimate minimum isolation distances) can be used to improve the well known methods adopted for controlling air-borne fungus diseases like spraying and dusting, eradication of the intermediate hosts and the practice of isolating clean plants and crops from sources of disease are discussed in this paper.

8. J. C. SAHA (Pondicherry): *Plant Quarantine as an aid to prevent and control of Plant Pests and Diseases.*

One of the recent developments in the field of plant disease and pest control is Plant Quarantine. Although this was practised in a more or less empiric way in earlier times, Plant Quarantine as an organized measure started with the enactment in the year 1912 in the United States of a comprehensive act, viz., the Plant Quarantine Act. This act helped to crystalize similar thinking in other lands and led to enactment of Quarantine rules and regulatory measure in other progressive

countries. In India too a separate Department was established in the late forties and was entrusted with such regulatory measures to prevent introduction of foreign pests and diseases and eradication of new or localized outbreaks.

For a quarantine to be effective, information should be obtained with regard to the biology of (i) the nature of the pest or disease, its life history, mode of dispersal; (ii) the extent of the present distribution of the pest or disease; (iii) the probability that the pest or disease lends itself to be introduced in the course of normal trade with foreign countries or territories; (iv) whether the pest or disease, if introduced, it is likely to assume any degree of economic significance, and (v) whether quarantine measures are likely to prevent the introduction of such new pests and diseases.

Having arrived at such a decision that a quarantine measure is likely to be of advantage to the country, its effective enforcement will require any or all such measures as placing (i) an embargo on the importation of the plant (or plant parts as the case may be), (ii) inspection at the point of importation, (iii) disinfection before the plant materials are released to the importer.

9. G. RANGASWAMI, RAO RAMA RAO and A. R. LAKSHMANN, *Studies on the Control of Citrus Canker with Streptomycin.*

Studies on the control of citrus canker, caused by *Xanthomonas citri* (Hasse) Dowson, with streptomycin sulphate were made. It was found that when aqueous solutions of the antibiotics, together with one per cent glycerin, was sprayed on acid lime (*Citrus aurantifolia* Swingle) seedlings, the antibiotic was better absorbed by the leaves, than when sprayed alone. Also, indications for the presence of the antibiotic in the leaf sap of three-year-old citrus plants in the field within 12 hours after spraying and also for its persistence up to 21 days after spraying were obtained. In the field experiments with 40 three-year-old plants, laid out in randomized replicated blocks, with five treatments and eight replications each, it was found that streptomycin sulphate at 1,000 and 500 p.p.m. sprayed at 15 day intervals effectively checked the disease but not at 250 and 100 p.p.m. Though the bacterium could be easily isolated from the plants treated with 250 and 100 p.p.m. of streptomycin sulphate, several attempts to isolate the bacterium from the spots from plants treated with 1,000 and 500 p.p.m. of the antibiotic resulted in the failure, thus indicating that the bacterium had been killed by the high concentrations of the antibiotic.

I. HOMEOSTASIS OF BLOOD PRESSURE

Section of Physiology

Chairman : DR. N. P. BENAWARI, Gwalior.

1. B. K. ANAND (Delhi) : *Nervous Regulation of Homeostasis of Blood Pressure.*

Blood pressure is controlled by chemical, nervous, and mechanical factors which modify the arteriolar resistance, the size of the capillaries, the venous return, and the rate and force of the heart's contraction, and thus influence both the peripheral resistance as well as the cardiac output. Out of these, nervous regulation is the most important for maintenance of the homeostasis of blood pressure.

Autonomic efferents, both excitatory and inhibitory, regulate the activity of the heart. The arterioles and capillaries throughout the body mainly get constrictor efferents; dilator efferents supply blood vessels only in certain specific regions. The effect of outflow of impulses through these is reflexly adjusted from the cardiovascular 'centres' situated in the brain-stem, the activity of these centres being

modified by a large variety of afferent projections. The afferents from the cardiovascular structures, in particular from the aortic and carotid sinus regions, play a most important role in bringing about homeostasis of blood pressure. Thus it is the pressure of blood in these big vessels which helps to keep the arterial blood pressure at normal levels. Special feature of this reflex auto-adjustment is that the sensitivity of baroreceptors in the walls of these vessels is maximum at pressure levels round about the normal blood pressure.

Although the homeostasis of blood pressure is reflexly maintained from brain stem levels, higher nervous regions have recently been shown to produce marked influences over this reflex mechanism. Hypothalamic regions were first shown to affect the blood pressure acting through the lower centres; increased activity of the anteromedial regions producing a fall in B.P., while increased activity of the posterolateral regions registering a rise in B.P. It is significant to observe that reserpine has been shown to inhibit the posterolateral hypothalamic regions and facilitate the anteromedial regions and thus bring about a fall in B.P.

More recent work has established an intimate relationship of the limbic system of brain ("visceral brain") to the adjustment of B.P. Stimulation of limbic structures in the frontal lobes generally produce a rise in B.P., while stimulation of limbic structures in the temporal lobes generally lead to a fall in B.P. Destructive lesions of these structures generally produce opposite effects on B.P., although the variations in B.P. are not so pronounced as after stimulations.

Thus it is seen that the higher nervous regions which regulate the affective behaviour and emotional activity, also regulate the various visceral activities including maintenance of normal blood pressure. A normally functioning limbic system is quite essential for the haemostasis of B.P. Disturbed activity of this central nervous system would disturb the homeostasis of B.P. and lead to the development of hypertension. The possibilities of therapeutic surgical lesions in the limbic system for the correction of hypertension are also there.

2. DR. S. R. MUKHERJEE (Calcutta): *Homeostasis of Blood Pressure.*

Importance of cardiac output and peripheral resistance in maintaining the blood pressure has been emphasised.

Importance of the nervous mechanism regulating the peripheral resistance and cardiac output, when there is a change in blood pressure, so as to restore it back to normal has been pointed out. The results of the experiments done on animals in which rise of blood pressure has been obtained by distension of the bladder are summarized as follows:—

1. Rise of blood pressure on bladder distension is more marked on bilateral vagotomy and carotid sinus denervation, and is abolished if bilateral sympathectomy is performed. If buffer nerves are absent then after the rise in B.P. the fall observed is gradual. Similar observations have been obtained by the distension of intestine.

2. Experiments on spinal cats on intravenous administration of adrenaline have shown a higher rise in B.P. and absence of notches.

In cases of hypothermia stimulation of baroreceptors showed no effect or very diminished effect on heart and blood pressure. It may be due to depression of the baroreceptors by cold. It may also be due to the heart rate and B.P. being low, a compensatory mechanism may be acting trying to keep the B.P. high.

The findings of various other authors showing the importance of buffer nerves in regulation of B.P. are summarised.

The importance of segmental and supra segmental mechanism in regulation of blood pressure has been pointed out.

A note of caution has been given that the role of limbic system in homeostasis of blood pressure should not be over emphasised. Reasons for this have been discussed.

3 DR. N. P. BENAWRI, DR. M. S. CHAUDHARY, and DR. S. S. SRIVASTAVA (Gwalior) : *Homeostasis of Blood Pressure.*

The important theories regarding the genesis of hypertension have been referred to. The lack of precise knowledge regarding the role of buffer nerves in cases of hypertension has been pointed out. McDowal's vago pressure reflex (1924) has been referred to. It can play an important role in antagonizing the pressor receptor response has been indicated.

Observation of the effect of the stimulation of the cut central end of the vagus have been summarized. The observation that cutting of both vagi give sometimes rise some times fall and some times no change in blood pressure of other observers has been confirmed.

Observations of other observers that there is rise in blood pressure on stimulating cut central end of vagus has been confirmed.

Statistical analysis shows that in majority of observations the rise of B.P. is the more significant response. Statistical analysis also shown that it is the increase in the voltage which is significant for producing the response and not the increase in frequency.

4. DR. K. P. BHARGAVA (Lucknow) : *The Spinal Vasomotor Loci and Homeostasis of Blood Pressure.*

The role of spinal cord in the control of vasomotor tone for regulation of B.P. has been emphasised.

History of the work done so far to bring out the importance of the spinal cord in regulation of blood pressure has been traced. The work of Cushing 1901, Groat and Peele 1945 and Borison 1955 in this connection has been summarized.

The result of the experiments done on pentobarbitalized cats, with vagi cut and spinal cord tied within the meninges at C-7 in which spinal compression was effected through injection of saline into the theca have been summarized.

It has been shown that thoracic region of the cord is the chief site concerned with the vasomotor response on spinal compression. Attempts to find out if the mechanism of excitation is pressure or ischaemia have indicated that ischaemia could not be the cause. Attempt to localize the receptor has shown that the receptors are not situated in the dura or the central canal but are situated on the surface of the spinal cord.

Ganglion and adrenergic blocking agents abolish the response. Hypoglycaemia, strychnine and metrazol facilitate the response.

Importance of the spinal vasomotor loci as the final common pathway for higher influences has been emphasized.

5 SUNITA INDERJIT SINGH (Delhi) and INDERJIT SINGH (Agra) : *The Role of Ions in the Maintenance of Blood Pressure.*

It is well established that electrolyte imbalance results in hypertension, so that electrolytes must be concerned in maintenance of normal blood pressure.

The increase in the sodium content of unstriated muscle increasess its tone, and increase in the potassium content has the opposite action. These experiments suggest that intracellular sodium increases tone and intracellular potassium has the opposite action.

The action of these ions has been directly tested on the smooth muscle of the arterioles of the dog's hind limb. This was done by letting the muscle die in isotonic solutions of these ions. As the muscles die, their permeability is destroyed, and the ions enter the muscle fibres and act directly on the contractile proteins. In this way it was found that sodium has a constrictor and potassium a dilator action.

Calcium has not been assigned any role in blood pressure. There is a natural increase of lime salts in the aged. By the above technique it has been found that

calcium acts on the contractile proteins of the arterioles and cause their contraction. Calcium might be therefore responsible for the physiological increase of blood pressure with age.

It appears that the three ions, sodium, potassium and calcium have some role in the maintenance of normal blood pressure.

6. DR. J. S. SAXENA (Hubli) : *Homeostasis of Blood Pressure.*

Importance of high-salt-diet as an important predisposing factor for Hypertension has been pointed out. Importance of saltless diet in the control of Hypertension has been indicated.

Observations of Tobian and Redleaf on giving D.C.T.M.A. with and without sodium chloride have been summarised. The observations clearly show the role of increased NaCl in hypertension.

Author's observations on saltless diet have been summarised and they point out to the fact that salt reduction is an important factor in reduction of B.P. The observations indicate that the normotensive individuals being on low salt diet show a lesser size of blood pressure during exercise and excitement.

7. DR. B. P. GHOSH (Calcutta) : *Homeostasis of Blood Pressure.*

At the outset it may be said that the subject for this discussion will be limited to mean arterial pressure and to those factors which relate to the biochemical aspect only.

The mechanisms for regulation of mean arterial pressure may be considered in five aspects :—

1. Neurogenic reflex system.
2. Fluid shift across the Capillary membrane.
3. Kidney control.
4. Control by Vasoactive substances other than V.D.M. & V.E.M.
5. Endocrine control.

An alteration in the following factors may bring about a change in blood pressure : Heart rate, peripheral resistance, quantity of blood in the arterial system, viscosity of blood, elasticity of the arterial system and venous return. Such changes in blood pressure are taken care of by the first and the second mechanisms. The kidney control mechanism however works only when the pressure remains too low or too high for several hours to several days.

(1) *Neurogenic Mechanism—*

According to this mechanism, the blood pressure is regulated through information being communicated by the peripheral arteries and areas in the brain to the Vasomotor centre. As a result, Cardioacceleration or Cardioinhibition, and Vasoconstriction or Vasodilatation occur. Pressure is thus regulated.

(a) The carbon dioxide level in extracellular fluid regulates pressure in two ways—

- (i) by its action on the sympathetic,
- (ii) by stimulation of the Vasomotor centre.

The direct effect of CO₂ on the Vasomotor centre is 10-20 times as great as the reflex effect.

(b) Oxygen lack in arterial blood causes rise of pressure.

(2) Fluid shift through the Capillary membrane into the interstitial spaces to and fro causes regulation of pressure.

(3) *Kidney Control—*

(a) In ischaemic condition of the kidneys, a substance known as renin is released. This acts on hypertensinogen to form hypertensin, a Vasoconstrictor material.

(b) Under anaerobic conditions, VEM, a Vasoexcitor material is formed. Its effect is counteracted by VDM, a Vasodepressing material.

- (c) Blood loss or depressed kidney function causes retention of fluid and electrolytes. The pressure is elevated in this way.
- (4) The pressure is also regulated by the following Vasoactive substances : Acetylcholine, Histamine, Adenosine and its derivatives, Kallikrin, Carbon dioxide, and O_2 in blood, Noradrenaline and angiotonin.
- (5) The hormonal regulation of pressure is done by Adrenaline, Noradrenaline and Vasopressin, a posterior pituitary hormone.

8. D. P. SADHU (Calcutta) : *Evolution of Homeostasis of Blood Pressure.*

The homeostasis of blood pressure is related to the temperature regulating ability of animals. Temperature regulation needs the differential distribution of blood between skin and internal organs and thus the activity of the vasomotor centre becomes related to that of temperature regulation. Poikilotherms lack an efficient mechanism of heat retention, hence in a low environmental temperature their metabolic activity is limited and as the ambient temperature rises, heat distribution to the body surface depends largely on an active circulatory system. The smaller reptiles are less dependent on their circulation and their temperature would have less of a lag behind that of the environment, compared to that of the larger reptiles.

In turtles and frogs, arterial blood pressure is directly related to blood temperature, but if the brain is pithed, blood pressure is no longer responsive to temperature changes. In birds and mammals, also, a drop in body temperature is accompanied by a decrease in blood pressure. It may be argued that the temperature-regulating centre of homoiotherms evolved from a region of the hypothalamus responsible for circulatory adjustment. Migration of vertebrates from water to land has been accompanied by development of a tolerance for greater and more rapid changes of external temperature than occur in water.

9. SACHCHIDANANDA BANERJEE and MRINAL KANTI MOOKERJEE (Calcutta) : *Blood pressure of guinea pigs.*

Blood pressure of normal guinea-pigs : Carotid blood pressure was determined in normal guinea pigs under urethane anaesthesia. The average blood pressure was 45 ± 1.7 mm. of Hg. The blood pressure recorded was considerably low as compared to other experimental animals. The low blood pressure was not due to urethane anaesthesia. Dietary deprivation of potassium causes consistent fall of blood pressure. The diet of the animals contained powdered wheat and gram which are rich in potassium. The serum potassium of guinea pigs was 20 ± 1.3 mg. per 100 cc. serum. The low blood pressure of guinea pigs is, therefore, not due to potassium deficiency. The serotonin content of guinea pigs' serum as has been shown by Erspamer, is 0.21 microgram per 100 cc. The value was low as compared to most of the laboratory animals like cat, rat and rabbits etc. The value in respect of dog's serum is similar to that of guinea pigs. It is, therefore, unlikely that the low blood pressure in normal guinea pigs is due to the serotonin content of blood plasma.

Blood pressure of scorbutic guinea-pigs : Carotid blood pressure of scorbutic guinea pigs anaesthetised with urethane was 37 ± 1.9 mm. of Hg. The blood pressure of scorbutic guinea pigs was significantly lower than the blood pressure in normal guinea pigs. The low blood pressure of scorbutic animals might be due to several factors which operate in scurvy. Importance of blood viscosity in the maintenance of normal blood pressure is well known. Vitamin C deficiency causes reduction in red blood corpuscles. It also produces lowering of plasma proteins specially the albumin fraction. These factors are likely to lower blood viscosity which depends on its colloid content and suspended corpuscles. When changes in resistance occur due to changes in blood viscosity, alteration in velocity of blood and vasomotor tone are brought into action which may completely or incompletely compensate for changes of blood viscosity. Vasodilatation of the peripheral vascular system has been reported

by Lee and Lee. If the vessels are sufficiently dilated, the heart may not receive sufficient blood to maintain normal pressure. Maintenance of arterial blood pressure is dependant on the stroke volume of the heart and also on its power of contraction. These are some of the factors which need further consideration to ascertain the cause of low blood pressure in scorbutic animals.

II. PULMONARY FUNCTION TESTS

Chairman : DR. N. P. BENAWARI, Gwalior.

1. R. VISWANATHAN (Delhi) : *Pulmonary Function Tests.*

It is only during the last few years that a large number of functional tests have been developed for the qualitative and quantitative evaluation of pulmonary efficiency. Tests for pulmonary function are as important as those for the functions of other organs like the liver, kidneys etc.

Pulmonary function tests cannot be expected to provide etiological or anatomical diagnosis. On the other hand, Physiological diagnosis can be made by the performance of these tests which enable the estimation of functional capacity. Sometimes these tests give information of prognostic import. They cannot supplant careful analysis of history, physical examination, radiographic and fluoroscopic examination, bacteriological or pathological studies. If the limitations of the tests are kept in mind, their value and importance can be better appreciated. The tests, however, lead to a better understanding of pulmonary physiology both in health and disease. They have aided in the early detection of pulmonary disfunction in some cases considered to be normal on the basis of clinical and radiological examination. They can also be used for the objective evaluation of therapeutic measures such as Oxygen therapy, IPPB, cortisone, inhalation therapy etc. They have also provided invaluable data in patients who are suspected to have pulmonary disability.

Just as in the case of other organs like liver, kidney etc. a single test can never give all the information desired in a patient suffering from a chest disease. A battery of tests have necessarily to be performed. Though gas exchange is the primary function of the lung, this involves a number of processes. Respiration has two components, internal and external. The internal respiration is concerned with the exchange of gasses between tissue cells and fluid bathing the cells. External respiration is the exchange of gasses between the blood and air entering the lungs. The latter is the subject of clinical pulmonary testing.

There are four basic mechanisms involved in external respiration. They are, ventilation, which is concerned with the movement of air in and out of the lung, intra-pulmonary mixing of the respiratory gasses, diffusion involving the exchange of Oxygen and the Carbon Dioxide across the alveolar capillary membrane, and the rate of circulation of blood through the lungs.

The various pulmonary function tests are calculated to determine the various components of lung-volume, measurements of ventilation, saturation and tension of gasses in the blood and the diffusion capacity of alveolar capillary membrane. There is as much need in the modern hospital for a lung station as there is for a heart station and one can be staffed and equipped at no greater expense than the other. It is not only economical but also desirable to have a combined heart-lung station as there are several common factors involved. This can no doubt be expected because of the close Anatomical and Physiological relationship between the heart and the lung. While planning a pulmonary function testing programme, a clear definition of objectives is essential. The nature and the number of tests to be performed will depend upon the technical, physical, and financial resources available. There is now fairly general agreement on basic equipment and efforts. Lung volume and ventilation studies with a recording respirometer are the basic minimum. Next comes the analysis of blood gases. When arterial blood is withdrawn for blood gas analysis, arterial pH, can also be estimated with a pH, meter. Diffusion

studies and pulmonary blood flow estimations are to be included in an expanded programme for a lung station. Pressure studies in the pulmonary vascular bed can be done only with cardiac catheterisation. This can be included in the function testing programme, when a cardiac station is associated with the lung station.

Accommodation and equipment required for a lung station will depend upon the number of tests included in the programme adopted by a particular institution. The equipment may vary from a hospital vitalometer to the inclusion of such costly and complicated equipment like the Mass Spectrometer.

The requirements of different types of lung stations will be discussed. Some of the pulmonary function tests done in the Vallabhbhai Patel Chest Institute during the last three years will also be given. The value of the tests in determining the organic irreversible component and the functional reversible component of bronchial obstructions in certain respiratory disorders will also be discussed.

2. DR. N. P. BENAWARI, DR. M. S. CHAUDHARY, DR. MRS. N. M. KHIRWADKAR, and DR. H. C. GUPTA (Gwalior) : *Pulmonary Function Tests.*

The classification of the Pulmonary function tests on their Physiological basis has been discussed. Importance of Ventilatory functions and the methods of their determination have been dealt. Importance of measuring the lung volumes at B.T.P.s has been pointed out, as also the decreasing importance of the static volume measurement as compared to the dynamic volume measurements. Importance of M.B.C. and its ratio with resting minute ventilation (Breathing reserve) and with walking ventilation in assessing the fitness of the patient for surgical intervention has been discussed.

			74 Male 1st series	26 female 1st series	100 Male 2nd series
Vital Capacity in lts. ...	Range		2.58 to 5.24	1.68 to 3.1	1.95 to 5.55
	Mean		3.42	2.189	3.52
	S.D.		0.552	0.352	0.613
M.B.C. in Lit/mt. ...	Range		77.16 to 179.56	53.85 to 114.16	81.08 to 168.42
	Mean		118.69	86.35	114.97
	S.D.		19.316	14.075	16.17
Resting minute Ventilation Lit/mt.	Range		3.736 to 10.520	4.214 to 7.941	4.199 to 12.816
	Mean		6.89	5.858	7.518
	S.D.		1.399	0.977	1.544
Walking Ventilation Lit/mt.	Range		9.016 to 21.79	7.508 to 18.120	10.127 to 22.514
	Mean		14.476	12.53	14.442
	S.D.		2.562	2.481	2.337
Breathing reserve % ...	Range		89.93 to 97.98	89.66 to 98.57	84.94 to 96.58
	Mean		94.07	98.16	93.225
	S.D.		1.565	2.309	not done
Walking Ventilation M.B.C. Ratio.	Range		0.0748 to 0.2055	0.0897 to 0.2297	0.0680 to 0.2122
	Mean		0.1243	0.1453	0.1254
	S.D.		0.02717	0.03478	not done
Surface Area. Sqr. Meter ...	Range		1.37 to 2.01	1.29 to 1.68	1.46 to 2.2
	Mean		1.65	1.45	1.686
	S.D.		0.145	2.288	0.156
Thoracic Index ...	Range		Not done	not done	65.65 to 84.8
	Mean S.D.				74.456 4.306

Normal values of vital capacity, Maximum Breathing Capacity, Walking Ventilation, and Breathing reserve have been determined in one series of 100 Medical students (76 male, 24 female). In an other series of 100 male Medical students a study has been made to find if correlation in the value of these tests and thoracic index exists or not. Results have been summarised in the table attached herewith.

3 DR. V. R. BAJAJ and DR. V. D. MULLICK (Patiala) : *Pulmonary Function tests.*

Normal values for various pulmonary function tests in 53 healthy Indian adults, 36 males and 17 females, in whom there was no personal history past or present of respiratory diseases like chronic bronchitis, asthma etc. were determined. The subjects were divided into two groups A and B, consisting of 27 and 26 subjects respectively. In both the groups values for tidal volume, inspiratory capacity, expiratory reserve volume, vital capacity and minute volumes were determined with the use of spirometers of two different types. In group A, in addition to the above, value for timed vital capacity maximum breathing capacity, functional residual capacity (by oxygen open circuit method as well as by helium closed circuit technique), intra pulmonary gas mixing and maximal mid-expiratory flow rate were also determined.

The average values in litres for males and females respectively were : tidal volume 0.614 and 0.425; inspiratory capacity 2.625 and 1.752; expiratory reserve volume 1.60 and 0.994; vital capacity total 4.226 and 2.566 and timed 1 sec. 75.8% and 81.1%, 2 secs. 91.1% and 94.1%, 3 secs. 96.9% and 98.3%, functional residual capacity (by HE. method) 3.418 and 2.365 and by oxygen method 3.116 and 2.006; minute volume 10.321 and 8.041; maximum breathing capacity 127.81 and 87.44; intra pulmonary gas mixing 1.508% and 1.58% maximum mid-expiratory flow rate 3.67 and 2.45.

It was observed that higher values were obtained with the use of the apparatus which offered least resistance to breathing and that variations occur between values obtained for Indian subjects and those reported for foreign subjects. The mean values for Indian adults both males and females, however, are in fair agreement with the predicted values obtained according to regression formulae of Baldwin et al. A number of derived values have also been worked out and a comparative study for Indian as well as foreign subjects made.

4. DR. H. SAHA (Calcutta) : *Pulmonary Function Tests.*

The value of Maximum Breathing Capacity (MBC) as a simple test for the assessment of the ventilatory function of the lungs has been well-established. MBC has been estimated in normal subjects in Western countries and recently in some laboratories in India. The estimate of MBC values in Bengalees will be presented in this discussion. The data will be compared with those of other publications. Special emphasis will be laid on the negative correlation with age and the importance of estimation of MBC of older age group of Normal subjects.

M.B.C. of Bengalees.

100 normal male subjects were selected as volunteers, with age varying between 17 to 64 years. 39% of the subjects were more than 40 years old. They were tested by open circuit method.

Result.

The MBC of the subjects varied between 68 lit. to 180 lit./min./BTPS. The MBC values showed a 'significant' negative correlation with age ($r = -0.62$; $t = -7.98$). The MBC of a subject could be predicted from the equation :—

$$\text{M.B.C.} = 18.61 \times \text{Age in Sq. m.} - 1.13 \text{ age in yrs.} + 120.19.$$

Comparison of the estimates on persons below 40 years with those above 40 years:

The mean value of the MBC of the former group was 120.4 lit./min. and of the latter group was 92.7 lit./min. The difference between the means of the two groups were 'Significant' statistically ($t=6.461$).

Conclusion :—It appears probable that there is a racial variation of M.B.C. like that of Vital Capacity. The values obtained by Bhargava and Somnath and by Sinha and Provakaran are higher. One of the factors to account for this discrepancy is the incidence of older subjects in the present series (39%).

The negative correlation with age and the statistically significant difference in the performance of the subjects above the age of 40 years suggest that a more elaborate work is necessary with subject of higher age group. This is particularly important because most of the patients suffering from chronic respiratory insufficiency are likely to belong to the higher age group.

5 DR. J. S. SAXENA (Hubli) : *Pulmonary Function Tests.*

Importance of Pulmonary Function Tests has been pointed out. The tests have been classified in two important groups (i) for testing pulmonary mechanics, and (ii) tests for diffusing capacity of pulmonary membrane.

In the first group importance of determination of maximum ventilatory capacity and ventilatory cost of exercise has been pointed out.

Alveolar air samples in Indian have been analysed. A method for collecting alveolar air in animals devised by recent workers.

The necessity of precision instruments in various tests has been pointed out.

Basis of determining the diffusion constant has been indicated. Limitations of the test as reviewed by Forster are pointed out.

Importance of the Arterial O_2 Saturation as an index of pulmonary efficiency has been indicated.

6. DR. D. N. SHIVPURI (Delhi) : *Pulmonary Function Tests.*

In patients suffering from severe and acute attack of asthma, tidal volume was about the same as vital capacity, but after administration of a bronchodilator, ventilatory values increase, although the per cent of increase in Midexpiratory flow rate is much less than in vital capacity and the per cent of 1 sec. vital capacity of the actual vital capacity does not show increase corresponding to the increase of vital capacity. This happens due to a very small increase of flow rate. Investigations into chronic asthma patients show that there is always a residual obstruction to the traffic of air and stroke of volume in chronic asthma even when there are no subjective symptoms of an attack. Midexpiratory flow rate is the most delicate and reliable index of ventilatory function in patients of asthma.

7. DR. V. K. SAINI (Vellore) : *Pulmonary Function Tests.*

Bronchspirometry gives only percentage values. Thoracoplasty leads to a loss of 15-30% loss of respiratory functions. It is difficult to correlate M.B.C. test with diaphragm movement in patients.

8. DR. H. B. DINGLEY (Delhi) : *Pulmonary Function Tests.*

A study of healthy Indians shows that there is a negative correlation between M.B.C. and age, weight and body surface area.

9. DR. B. BHATTACHARJEE (New Delhi) : *Pulmonary Function Tests.*

In pneumonectomy, it is necessary to know if the entire cardiac output routed through the circulatory bed of one lung is going to have adequate gas exchange. For this, measurement of pulmonary arterial pressure during unilateral occlusion of pulmonary artery will be helpful. It will be useful to estimate alveolar ventilation/pulmonary capillary blood flow to know if pulmonary functions after lobectomy will be adequate for carbon dioxide elimination in the immediate post-operative period. A greater understanding of lung/thorax compliance is necessary.

10. J. S. KARANWAL (Delhi) : *Pulmonary Function Tests.*

Bronchspirometry is very useful to thoracic surgeons for decision on the extent of excision of lung tissue.

11. M. S. CHAUDHURY (Gwalior) : *Pulmonary Function Tests.*

There is a good correlation between M.B.C. and maximum diaphragm movement, but no regression equation has yet been found out.

I. ROLE OF PSYCHOLOGY IN COMMUNITY DEVELOPMENT PROGRAMMES IN INDIA

Section of Psychology & Educational Sciences

Chairman : PROF. S. JALOTA, Banaras.

1. DR. A. K. P. SINHA (Patna) :

In opening the symposium, Dr. A. K. P. Sinha observed the following :

Although the Community Development Programmes and N.E.S. Programmes have been in operation in India for over six years, the accomplishments have fallen short of expectations. One factor responsible for this is the fact that Psychology plays an important role in planning and successful implementation of these programmes has not been duly recognised. It, therefore, becomes necessary to approach the problem psychologically.

In view of the prevailing state of affairs, the following suggestions are offered for considerations—

1. Preliminary survey of the needs, beliefs, attitudes, prejudices and stereotypes—Before undertaking the work of community development programme in any area it will be worthwhile to have a first hand knowledge of the needs, beliefs, attitudes of the people of the locality for successful planning of the programme depends upon this fact—or more than anything else.

2. Planning of the programme—After having known the needs of the people, the plan for the satisfaction of those needs should be chalked out in co-operation with the people concerned. Care should be taken to engender such changes in the psychological functions of the individuals concerned as may arouse a sense of ego-involvement, a sense of belongingness and the like which alone would ensure maximum participation by the people.

3. Selection of Personnel—It is a common observation that most of the people do not want to live in the villages and work there, and so, if they are entrusted with the work of community development and the N.E.S. programmes, they will prove failures in as much as they will not be able to arouse such feelings in the village people as are necessary to secure their co-operation because of their own lack of interest in rural life. Selections, therefore, should be made with the

aid of suitable psychological tests and devices so as to ensure the services of only such persons as may be strongly motivated to work actively in a village atmosphere.

4. Training—The persons selected for working at the project level, consisting of the Project Executive Officer or the Block Development Officer, the technical expert in health, agriculture, co-operation, animal husbandry etc. and the village level workers should be given training in the social psychological principles underlying "Community life" along with other types of training in responsibilities and duties which they are already given at the various centres of training now in operation. They should be specially given training in leadership along psychological lines. Of all the techniques, the technique of role playing has been especially found to be more effective in as much as it provides opportunities for gaining new perspective on the motives, feelings, ideas and thoughts of the people with whom they have to work.

5. Research—Considering the importance of the nation-wide experiment that is being conducted in our country, it is equally necessary that a good deal of research work on different problems relating to these programmes be done with a rather rapid pace. Since these programmes concern different disciplines such as sociology, anthropology, public administration, psychology, it is necessary that specialists in these fields should hold joint conferences from time to time and plan and conduct multi-disciplinary research. This kind of research promises more fruitful results in attacking a number of social problems.

In conclusion, it may be said that the success of the community development and N.E.S. depends not only upon the active co-operation of the rural population with the government, but also to a very great extent upon the co-ordinated efforts of the experts of different social sciences in conducting valuable researches on problems relating to them.

2. INDRA SEN (Pondicherry) :

I. Is this work not essentially psychological viz., that of recording the mind of rural India, changing it from a traditional habit to a progressive form? If so, then the force that can bring about this change must be the impact of a progressive mind, which can give the joy of reflection on life and its situation and impart the will to improve it. Evidently, then the agents of the work have to have this mind and mentality. If they have a routine mechanical mind they will be psychologically handicapped.

II. Further, if the objective works and their targets of achievement receive a strong emphasis, then psychologically a perverse situation can arise, viz., Government and its agents being more anxious than the people for whose good things are being done. The people then begin to stand apart, merely watch and even take perverse attitude towards the works. The works then do not contribute to their growth.

III. Man and investment in man are now happily recognised as the true national assets. They are essentially psychological facts. Community Development Programme can never afford to forget these. Every bit of the programme and its progressive success will have to be judged and tested by reference to man and his growth and nothing else. If this is not done, things may prosper, but man will languish. Further, if man and his growth or the amelioration of the human assets of a nation is the objective, then a careful study and understanding of the nature of growth and its conditions become important. In fact, it will be well worth recognising such study as an integral part of the Development Programme. In this connection it may be observed that the past traditions and motivation of a people are the means for new growth, though also its obstacles. The attitude of endurance, faith and peaceful contented living of the Indian mind should not be ruthlessly

shaken and damaged by arousing greed, avariciousness and competitive activity, but steadily re-educated into a more enlightened form.

IV. Even when the aim of the work is conceived objectively as the achievement of things—change in the environment rather than in persons—then too one can pursue the realisation of them psychologically. That is, in the choice of the means and the methods one avails of psychology. Here the end becomes non-psychological but the means remain psychological.

3. D. BAGH (Sriniketan) :

Psychology can help Community Development Programme in its various fields, as the development worker has to deal with people in order (i) to develop a favourable attitude towards various programmes, and (ii) to initiate action among people for their own development. I would like to touch only one aspect of this Community Development Programme namely the *training of personnel*; and I would like to restrict myself only to three categories of functionaries on the block level: (a) Village Level Workers, (b) Social Education Organisers, and (c) Block Development Officers.

This discussion will be based on a hypothesis, that in order to bring better results in the Community Development Programmes it becomes imperative to create better workers. Considering the nature of the work that the above functionaries have to do, the existing training patterns are inadequate. So in order to provide better training it is necessary that the courses are psychologically oriented more than ever done before.

To raise the standard of these workers some points are suggested below which may be taken into consideration in the training programme. In all these cases psychology can help considerably :

(a) In selecting suitable candidates. (b) In reorganising courses of study. (c) In helping the trainees to unfold and adjust their own personalities (giving them psychological guidance where necessary). (d) In building a favourable attitude not only to work programmes, but also towards their own colleagues. (e) In developing an integrated democratic approach towards the whole programmes.

The Programme Evaluation Organisation (P.E.O.) had drawn attention to many defects that had been committed in the past. And if psychological methods and technics are applied in future, it is hoped that most of the defects investigated by the P.E.O. and other agencies may be successfully remedied.

It will be interesting to note that whatever may be the area of activities in the total Community Development Programme, the workers at all levels often meet interacting situations. Almost all these situations are found to be highly psychologically charged and a worker without sufficient knowledge in the science of human behaviours fails to understand the importance of the situations and is unable to exercise any control over them. So, to be an efficient worker in the various fields of Community Development it is essential that he gains some working knowledge in understanding the meanings of human behaviours observed in different situations, and knows how to induce human energies to constructive channels.

4. T. B. NAIK (Chhindwara) :

I will speak with special reference to a tribal area in which I have worked. It is the Tamia Multi Purpose Tribal Block, whose headquarter is Tamia, 3300' above sea level and 34 miles to the North-West of Chhindwara, Madhya Pradesh. The Block is strewn with hills and has many rich forests. The main population is tribal, Gonds and Korkus. Social Psychology will play an important role in the Development Programme in this area. Some of the fields which need mention are as follows :

Leadership : Only a thorough-going psychological study will answer such questions as, who is a local leader in such areas? What are his chief characteristics? Is leadership status achieved or acquired? What are the different types of leadership found in these people? How can these be used for development purposes?

Group Dynamics : Another is the field of group dynamics. It will help in understanding the effect of leader and member personalities on group behaviour, the causes and consequences of group cohesion and inter-personal conflicts. We come to know if there are any factions and on what basis they are formed; what faction is more dominant than the rest and why. How are decisions taken and implemented? (All these will be useful to know in view of the recent move in the direction of democratic decentralisation and working all development through the village panchayats.)

People's Attitudes : With the help of Psychology, again, we can arrive at the correct answers to such questions as these : What do the tribals think about the programme, e.g., about the schools, maternity homes social education? How do they react to the development personnel? Some programmes and persons are not liked at all. Some get a positive response. How can we win over the tribals to the programmes and the personnel? What kind of personality is necessary for working out the programme in such areas?

Primitive Psychology : An understanding of the principles of Primitive Psychology is very essential in working out publicity schemes in these areas. To give just one instance : When a film is shown to the tribals on some aspect of the plan they are not able to grasp the complete meaning of the story. They can perceive each separate item—an agriculturist going to his field with his plough, a tree with fruits, a monkey running away from a tiger; but their contextual meaning in the situation or arriving at the abstraction or the concept from these items is not possible for them. (We are trying to study the attitudes of the tribals towards various publicity media and the difficulties they feel in understanding them in the Tribal Research Institute, Chhindwara.)

Shri Meher C. Nanavatty (New Delhi) also participated in the discussion.

II. PSYCHOLOGICAL AND PHYSIOLOGICAL BASES IN THE STUDY OF PERSONS

Chairman : PROF. S. JALOTA, Banaras.

1. MADAN SINHA (Gorakhpur) :

In opening the symposium Dr. Sinha observed :

Today, a connotative definition of personality, of agreed significance, does not exist in the field of psychology. But, it does not pose a problem to psychologists. Because, at this age of scientific research even a reasonably complete definition of any thing is out of question.

A psychologist is directly concerned with the manifestations of personality. The manifestations of personality are affected by genogenic, histogenic, chemogenic and psychogenic factors. Genogenic factors have their source chiefly in heredity. Histogenic factors are those in which the predominant part is played by non-hereditary make-up of the nervous system. Chemogenic factors have their origin in the effects of the chemical agents on the nervous system. And, psychogenic factors are the experimental variables arising from all the establishments of person's thoughts, conflicts and decisions.

Much evidence goes to show that the brain is the locus of integration which is manifested in all co-ordinated and effective actions of the total organism. The present paper aims at discussing the cytoarchitectural map of the cerebral cortex in the light of some recent experiments.

2. A. K. P. SINHA (Patna) :

Human behaviour is highly complex. It is, therefore, natural to note disagreement in this field. A multiplicity of definitions of personality and a corresponding multiplicity of methods of study have been advanced by numerous workers in this field. Emphasis has sometimes been put on physiological and sometimes on psychological factors. A number of theories of personality have come into existence. Some theories have even gone far ahead of the development of measuring instruments. And, as yet there is no generally agreed upon criterion for deciding upon the relative merits of the different theories of personality.

What we need, therefore, is to make efforts to co-ordinate constructs and methods. The crucial test of any theory lies in its ability to improve the prediction or control of behaviour. It is necessary then that a good deal of research be done in this area so that we should be able to control and predict behaviour and make generalisations which may have real scientific value.

3. INDRA SEN (Pondicherry) :

I. The form in which the issue is raised involves an assumption, viz., that of the disparateness and ultimateness of Mind and Matter. The more fundamental issue involved is that of the right approach to the study of personality. Accepting the issue in this form (and it will in the end possibly satisfy our curiosity regarding the psychological and physiological bases too), we would affirm that the right approach to the study of personality is that of taking it as an object in nature, an object presenting self-conscious organisation, the highest in all nature. As such also presenting in itself the three steps and stages of natural evolution, viz., Matter, Life and Mind, mind being the last product of the process. Human personality is, therefore, a synthesis of matter, life and mind, characteristically operative under the emergent quality of self-consciousness. Matter, life and mind constitute in natural evolution a progressive growth of inwardness. Matter is all a thing of external relations. Life has an inner organisation. Mind can be self-conscious. And yet through self-consciousness it organises externally determined sensations and feelings. The self-consciousness seems to come fully to its own in the fact of self-existent consciousness of the spiritual individuality as affirmed by yogic and religious experience.

II. Personality then must be affirmed as consisting of four ascending levels, three operative and the fourth indicated as a goal and possibility. Matter, Life, and the Spirit. In this conception the physiological in personality would be represented by matter and life or the animate matter in it. However, certain parts of it e.g. the endocrine glands are more intimately related to the quality of personality than others. Mind too is not all conscious. The all conscious is the spirit. In mind there is the range of purposive thinking and also that of mechanical movement of ideas. Freud has affirmed nine-tenths of our life as unconscious. Nor are all physiological factors unconscious. Some are more amenable to conscious control, some less. Does this responsiveness not show in them a consciousness of a grade. Hatha Yoga demonstrates that heart-beat can be brought under control, so also many other involuntary functions.

III. May it not be that our personality is one conscious-unconscious dimension and that matter, life, mind and spirit represent different stages of it. On the lower ranges mechanism seems to be the determining principle and on the higher conscious purpose. If this is true, then we get a new orientation of the psychological and physiological bases in the study of personality. That the two are not separate and disparate, but continuous and progressive and that evolutionally the conscious is the later, the higher, the ultimately determining and the unconscious the earlier, the lower, the instrumental.

4. HARERAM HAJRAH (Asansol) :

The success in the management of a family, or the administration of a state depends much on the efficiency of a personality. The selection of personalities for responsible public services in India, is a crying problem, which can, to a great extent, be solved by the psychological and physiological study of a personality.

Personality, like a spring, reveals itself through words and actions. Actions may conveniently be analysed as the physiological basis of the study of a personality. A man of stronger personality is naturally more active, assertive and radiant with vivacity. His gestures and postures radiate energy. His eyes speak; his voice commands, and his very movements silence indiscipline.

Words indicate motives. They come out from the central control room,—I mean the mental structure. Hence their study is essential for the valuation of a personality. The age-old maxim "words indicate character" is not psychologically unsound. For the selection of worthier men with genuine personality, the modern psychological tests may now be conveniently introduced in our country with the help of the experts in this field of knowledge. This is actually being done in many progressive counting of the world to-day, and is yielding satisfactory results.

5. DR. H. N. MURTHY (Ranchi) :

The Clinical contributions to the study of the physiological and psychological bases of human personality are considered in this presentation :

A. Diagnostic psychological testing and its findings; the dimensions of neuroticism, psychoticism and introversion and extraversion. The relation of sedation threshold to Intra-Extraversions; conditioning and neuroticism; objective test findings and psychoticism.

B. Treatments in the clinic and its contributions :

(a) *Physical treatments* : Shock-treatment and personality changes as revealed in behaviour ratings and psychological tests. Chemotherapy and changes in the personality: anxiety and drugs, LSD and Psychoses, etc. Psychosurgery and personality changes: leucotomy cingulectomy, lobotomies. (Disturbances in Personality and Organic brain pathology).

(b) *Psychotherapy and personality* : Psychosomatic illnesses, Stress and role of psychotherapy. *Neuroses and psychoses* : Individual treatment in adults and children. Developmental and learning theories. *Group-psychotherapy* and personality change : sociodynamics of mental illness.

Summing up : Biochemical, Electrophysiological, psychological and social influences (including genetical aspects also) in the determination of personality. A multidimensional approach to the understanding of personality.

Udai Shankar (Jullundar), Sarkar (Delhi) and Sayeed (Aligarh) also participated in the discussion.

III. EVALUATION OF VOCATIONAL AND EDUCATIONAL GUIDANCE PROGRAMME

Chairman : PROF. S. JALOTA, Banaras.

1. DR. S. M. MOHSIN (Patna), opening the symposium stressed the difficulty of evaluation.

2. CHARLES WAINWRIGHT RIDDLE (Jullundar) :

The Punjab is one of the few remaining states that has no organized programme for providing guidance services for secondary students. The speaker,

therefore, cannot evaluate or assess a non-existent programme; but he would ask how certain problems have been solved by those who have established successful services.

One question concerns the training of guidance workers. As a science, psychology is not concerned with ethics. However, the psychologist may find himself contemplating on how the individual *should* perform as he studies how the individual actually *does* perform. The problem of "oughtness" lies in the field of ethics, not scientific psychology, but it is one that counsellors constantly face. What have directors included in their training courses that have helped the counsellor trainees harmonize their scientific training with the demands made upon them for ethical judgments as they work with young people?

Another question concerns public relation. "Guidance" has long been associated in India with dream interpretation, tea leaves, and palm reading. Many people, educated and non-educated alike, apparently place considerable confidence in astrological charts for securing guidance for their future actions and planning. How have directors convinced the public of the relative accuracy and validity of the help given by their programmes even though no attempt is made to ascertain the destiny or "karma" of the individual?

The last question concerns the services provided youth. Existing guidance programmes are generally to be found in urban centres, but most of India is rural. What guidance services are now being provided for rural students and what other services should be provided for them if their needs are to be met?

The assessment and evaluation of guidance services often deal with problems of administration and of constructing and validating psychological tests. We of the Punjab need to be conversant with such problems, but we also need to find the answers to the three questions set forth by the speaker.

A. E. Harper (Allahabad), N. Sen (Bangalore), H. Datta (Delhi), Prayag Mehta (Surat), S. Ghosh (Delhi) and N. L. Dosajh (Jullundar) also participated in the discussion.

I. TRAINING OF TECHNICAL PERSONNEL

Section of Engineering and Metallurgy

Chairman: DR. M. DATTA, Calcutta.

1. S. V. C. AIYA (Ahmedabad).

Technical personnel can be classified into various categories. Of these, the important category is personnel for research and development work. Persons trained for this category are very few in India and unless intensive training work is undertaken, the nation's progress will be delayed.

For research and development work we require an engineer who is well trained in the basic scientific subjects like physics, chemistry and mathematics and who has the capacity to follow developments in these subjects without much effort. In addition he has got to be a properly trained engineer. Thus we require engineer scientists. For a proper training of this type of personnel, a new approach has to be made in the country. We should provide engineering courses of shorter duration than the present ones for those who graduated with physics and mathematics, preferably with Honours in physics or mathematics. After the completion of the course, the persons concerned should be trained for a year or two in research. During this period, frequent visits to engineering installations have to be planned for giving practical bias to research investigations,

2. J. N. BASU (Calcutta).

The first engineering institution in India was started at Roorkey in 1847. A few years later, three industrial schools at Madras, Poona and Calcutta were converted into engineering colleges. The Victoria Jubilee Technical Institute was started in Bombay in 1887. The Indian Institute of Science, The National Council of Education—now Jadavpur University, the Benares Hindu University and many others came into existence in this century. Compared to the initiation of technical education in other countries—namely U.K. in 1790, France in 1794, U.S.A. in 1823, Germany after Franco-German war in 1872—India was not very far behind. But the progress of technical education and the quality of the outturns were admittedly much behind those of the above-stated foreign countries. The reasons for this are (a) Political dependence, (b) limited outlook of the functions of Indian engineers in Government and Semi-Government services, (c) want of research and Post-graduate training, (d) narrow view of engineering profession, (e) psychological disinclination of the young men of the country at the early stages for engineering study and many others. Lack of knowledge of business administration, industrial finance, human relation etc. on the part of engineers affected their quality; and it was lost sight of, that the knowledge of these for business success is as important as that of engineering technology. The result is, according to University Education Commission, that the engineers with a few notable exceptions were found not prepared to take a broad and inclusive view of affairs nor to take significant part in the determination of State policy, even relating to large engineering projects.

It is very unfortunate that even 10 years after Independence and enormous change in the outlook and training, Indian engineers are deprived of their legitimate share of responsibility in the moulding of the socialistic pattern of society which depends greatly on the engineering and technological improvements and skills.

To improve the quality of training several engineering colleges in India are introducing post-graduate study and research; moreover the subjects like industrial administration, humanities, engineering economics, industrial legislations etc. are incorporated in the syllabus of graduate training.

The Table I, shows the outturns of engineers in different branches all over India in 1954 as well as the additional intakes in the Second Five Year Plan as recommended by the Technical Man-Power Committee and accepted by the All-India Council of Technical Education. The percentage increase in annual intakes in graduate courses is 83% and that in diploma courses is 266%. The higher increase in diploma-training is justified as otherwise the existing low proportion of diploma to graduate, which is only 2264/2847 i.e. 0.79 is liable to create unbalance in the training of different cadres.

The additional intakes in graduate and diploma trainees are distributed to different places in each region of the country according to requirements.

Besides, there exist arrangements for the training of technicians and factory apprentices, which are greatly accelerated during the second plan period. The Small-Scale Industries Board, Government of India, intends to further accentuate the training facilities of this cadre even through enactment, if necessary, to make it obligatory on each industrial undertaking to admit a fixed number of apprentices according to its size.

The questions that are in the minds of many connected with technical education in this country are the following, which requires solution after due scrutiny. I leave them to be answered by those who share responsibility in this vital matter.

- (a) Whether proper balance in different cadres of technical persons is created or will be created and maintained by the measures adopted.
- (b) Whether increase in graduate trainees is not much above requirement.
- (c) Whether standard of graduate training can be properly attained for the additional intakes under the existing conditions of availability of men and equipments.

TABLE I—TRAINING
GRADUATES

		Mech.	Elec.	Civil	Tele- com.	Mining	Metal	Chem. Eng.	Total	Remarks
1.	Total outturn in 1954	670	555	1,083	49	64	65	361	2,847	
2.	Additional Requirements	5,166	5,473	11,114	1,320	469	693	2,256	26,491	
3.	Suggested Additional annual intake.	450	450	1,050	280	75	60	...	2,365	increment in additional intake = $\frac{2364}{2847} = 83\%$
DIPLOMA HOLDERS										
1.	Total outturn in 1954	494	370	1,143	44	7	20	186	2,264	
2.	Additional Requirements	12,041	10,421	25,705	562	692	204	806	30,431	
3.	Suggested Additional annual intake.	1,600	1,300	2,900	40	150	50	...	6,040	increment in additional intake = $\frac{6040}{2264} = 266\%$

3. PITAM CHAND GUPTA (Delhi).

The need of training for technical people arises from the fact that technical work has to be learnt in two phases—one in the grasping of an idea and the other is the actual application of that idea to a practical case in our day to day work. Thus in a college or school imparting technical education, one has to sit in a class to listen to someone talk on technical matters and then to go to the equipment to learn and practice to actually operate it. To acquire a complete mastery of all operations of a certain job can be defined as training of that job. This sort of combined education is not given properly in any one place and is bound to take quite a long time to produce a perfect person. The training which is an essential part of the technical education can be imparted in different ways. However, there is only one right way which can produce the best results in the shortest possible time.

Apart from the technical aspect of training one has to learn about the human aspect of it as well. This is many times lost sight of by the planners. It is nevertheless certain that even a hundred per cent technically perfect plan may be set to naught by neglecting the human factor. The best training is said to be one which makes the men happiest because then they are most useful to their firms. Due to the rapid industrialisation of the country more and more persons are needed to handle all the technical jobs. The problem becomes all the more acute due to lack of proper training schools following scientific methods of training. A cry is, therefore, heard all over the country that there is shortage of technical personnel.

It has been pointed out that if training needs are carefully analysed and understood in terms of a specific job; the suitability of a person to receive the training is decided without any prejudices, it is possible to successfully train a required number of men in the shortest possible time. It will then be within our reach to meet the heavy demand of technical people in the country.

II. PROPAGATION OF ELECTROMAGNETIC WAVES

4. S. V. C. AIYA (Ahmedabad).

There are two aspects of this work. The physics and engineering of radio has gone on hand-in-hand. For investigating the physical aspects of propagation, a large amount of accurate and detailed data is necessary. Such data can be used for engineering evaluations. However propagation engineering has now become a separate subject in itself. In communication service calculations, we require average values of ionospheric data or ground conductivity dielectric constant etc. Such average values are required for a sector of a day for a season. It is possible to obtain data required for propagation engineering with minimum expenditure by carrying out atmospheric noise measurements. A brief account of this work done by the author and the possibilities of its extension in future is discussed in detail.

THE SOCIAL IMPLICATIONS OF TECHNOLOGICAL ADVANCE IN INDIA

Committee on Science and its Social Relations

Chairman :—PROF. NIRMAL KUMAR BOSE, Calcutta.

A

1. M. P. MADAN (Lucknow) : *The Socio-Technological Pattern—To-day and Tomorrow.*

1. For better or worse all of us live in a technological world, quite different than yesterday. In India, the changes are so swift that few of us realise that we

are partners in a great revolution that is taking place in the country. The changes can be measured in terms of as small as our daily habits and as large as our currently operating national plans . . . our day to day living and social relations with our fellow beings. Commonsense ideas and technological concepts . . . our everyday decisions, etc.

2. Technical accomplishments and their effect in political and social thinking of society, in our approaches to live and let live . . . technology and science as guiding factors to human conduct . . . social necessities and their influence on the progress of technology in India . . . awareness of our dependence on technological proficiency.

3. Popular notions in society about technology and men in technology . . . indifference to human problems.

4. Religious convictions of Indian society and technological advances . . . conception of God and doubts.

5. Educational implications of technology in the country.

6. Technological advances and the shaping of our social behaviour and cultural approach to related problems.

7. Modern technological theory "It is change in technology, that produces change in the rest of the society" . . . social 'resistance' or opposition of varying degrees to technical development in India and changes in established methods. Reasons.

8. Social environment of to-morrow . . . some problems and general principles. Proposals.

2. PROF. S. R. PALIT (Calcutta) : *Should New India pass through the Technological Phase with the same process and consequences as in the West?*

A society is but a reflection of the stage of its technological progress and the peculiar genius of its people. Every progress in technology irrevocably affects the social pattern, its economics, its culture, its basic human relationship and, above all, its concept of social values.

The society in India bears the indelible mark of the vile and benign influences of feudalism, casteism, individualism, irrational fatalism and isolationist tendencies, and despite this, our native genius has succeeded in shaping all these social forces into a philosophy of life and social pattern with emphasis of inner satisfaction. With every step forward in our technological advance, these social adjustments of ours are receiving rude jolts, and the society is reacting rather slowly but surely to adjust itself to these shocks. We are noticing round us unmistakable signs of these changes in the progressive breakdown of the joint family system, the loosening of the family tie and the clan and caste unity, the emancipation of the women and their increasing role as bread-earners, revolt of the youth against social taboos, keener competition and its consequent frustration, and so on.

The West has paid high social price for its technological advances and its resulting higher standard of living through the complete dissociation of the society to the minimum-size unit and the maximum randomization of these social units. The dissociation and randomization have released social and economic forces and counterforces resulting in a faster tempo of life with its consequent greater incidence of high blood pressure and heart attack, increasing enjoyment with decreasing contentment, the curse of lonely old age, constant clash of personality even in the domain of love, affection and cordiality, culture which cultivates the mind less and less and a crushingly competitive economic system.

The crucial question for us at this junction is : can our society enjoy the fruits of technological advance, without paying the corresponding heavy social price? Is our native Indian genius with its peculiarly native kind of silent strength capable of meeting of this challenge in our own unique way with minimum "blood, sweat and tears" and maximum inner contentment. Are we going to sell our soul by cease-

less sham apeing of the West to effect this transition to a higher standard of life, or shall we be able to evolve an integration of the coming industrialisation to our social framework through our inner strength and higher philosophy entailing little of the irrevocable sufferings which are crushing the soul of Western society to-day. India has peacefully assimilated every new social challenge in the past and she has to do it again at this present juncture before the longing wondering eyes of the rest of the world.

3. BALDEV SINGH (Hyderabad) : *Gap between Science and Technology in India.*

Technological advance in an under-developed country creates a characteristic pattern in the field of science. The most prominent feature is the increasing gap between the highly developed technology and the comparatively backward science. The urgency of raising the standard of living of the people in backward areas necessitates importing of highly complicated machinery, instruments and advanced foreign technical know-how. On the other hand, the low level of education and research particularly in the fields of science and technology, is inadequate to meet the requirements of technical man-power and skill. The administrative machinery is also unsuited for a rapid development. This creates a situation where industrialisation proceeds apace while science lags behind, thus increasing the dependence of the under-developed countries on the more advanced ones.

The situation can be remedied by an appreciation of this fact of devising suitable steps to close the gap. The rate of the self-sufficiency of the under-developed countries in the matter of industrial and technical progress will be in direct proportion to the efficacy of the measures taken. Some suggestions are offered for remedying the situation.

4. INDRA SEN (Pondicherry) : *The Social Implications of Technological Advance in India—A Psychological Approach.*

1. Technological advance would mean more machines, more factories, more production, more consumption and extensive social living hinged on to machinery, factories and production and all social life brought under its regulative influence of patterned uniformities and variations.

2. The first social consequence of it possibly will be regularity, orderliness, mass collaboration and a wide appreciation of these values in national life. A higher standard of comfort and much general activity will also follow.

3. Psychologically speaking this would mean a mechanical growth of the national mind and this could mean a great advantage in our country where the values of the 'individual' have been stressed even at the cost of the 'social'. Industrialisation will inevitably lead to considerable equalisation in society.

4. But industrialisation with its emphasis on the machine would normally lead to the mechanisation of mind and a weakening of the sense of 'purpose' and 'values' in life. It is however, the pursuit of 'purpose' and 'values' that brings about in individuals the emergence of new higher qualities of experience which offer new avenues of growth for the race as also solutions for the insoluble problems of the age.

The world, in particular the West, is to-day confronted with such a situation. In the midst of the exceptional resources of power given by Science, man finds himself rather exceptionally helpless. He feels that these very means might annihilate him and wipe out everything. We have become so mechanised that we do not even suspect that there may be new qualities of experience which might reconcile the contradictions of the present—a love, an organic sense of unity, which might heal the national hatreds and discords of to-day.

5. This is a disastrous social prospect of technological advance in India. This becomes acute when we contemplate that India has in recent times already contributed some striking new qualities of experience, which have raised much hope in the world. Because of her traditional emphasis on the individual and the individual's venture into the infinite realms of experience, she may be expected to contribute more of it in the future.

6. But must industrialisation necessarily lead to a wholesale mechanisation of mind? This would be the inescapable result, if technology were accepted as the principal object of cultural pursuit and everything else in life subordinated to it or given a secondary place.

In the right consideration of things technology is just a means for creating better conditions of living. Given these conditions, life should be able to pursue and realise its highest values more effectively. Thus inherently there is nothing in technology.

If the country keeps these values in view and duly relates them to technology, then technology will be all blessing and it will also receive the perspective it needs so urgently for the world as a whole.

B

5. A. RAHAMAN (Roorkee) : *The Implications of Technological Advance in India : Housing Problem.*

Technical advance leads to greater concentration of population in cities and expansion of cities to accommodate growing population creates three major problems; city transport, housing and food supplies. All the three problems need immediate concentrated attention necessitating radical changes against the present stop gap arrangements and short range thinking. The paper discusses only housing.

There are at the moment two trends; that of luxurious buildings and low cost housing. The aim in low cost housing is one of making independent small units built of cheap materials, occasionally without modern amenities. This trend is based on ignoring sociological studies and is based on certain social assumptions which are not valid, and is an interesting example of lack of co-ordination between the sociologist, engineer and town planner.

It assumes that all that a modern worker needs is a roof over one's head, that the husband would be having a profession and wife would do all the household work. Consequently one or two-room independent units are being built with cheaper material and of shorter life. The main economy being in built in area and shoddy materials. This does not suit the present conditions as families are large and very soon the house is turned into a slum, with lack of privacy and development of tension between the residents, and as the tempo is faster and demands of life are more exacting this affects efficiency in work and health of the resident. Secondly, building of such tenements means unnecessary expansion of the city which creates the problem of transport of to and fro from work, shopping facilities and cultural amenities. Building of colonies at distance is exacting physically and financially but its greater effect is on cultural life, in so far as it deprives the residents of the far flung colonies from active participation. This is the case in some of the major cities, particularly after the partition in India. Another equally important, perhaps more, is the effect on education. The far flung colonies deprive the residents of good educational facilities for their children or make the cost exorbitant.

The rapid rate of technological advance in India necessitates, therefore, a bolder and imaginative thinking on the part of the planner in order to raise the standard of living of people and to get the maximum participation of people in the activity in a more creative manner. It is neither desirable nor necessary for India to undergo the social experience of the European countries that followed in the wake

of technical progress. It is the task of the planners to do so by correlating diverse fields of specialisation and by imaginative thinking and taking of bold steps.

6. **ING. DR. M. P. VARSHNEY** (Kharagpur) : *Integrated Engineer and Fellow Workers.*

Every country is faced with the problems raised by technical advance in varying degrees, depending on its social pattern and its state of development. There is no doubt about what engineers have done to help make life better for more and more people and that these changing times ask more of engineers and need more from engineers. The problem of adaptation to new techniques and its implications has been discussed under two aspects :—

- (i) an engineer's outlook towards society, and
- (ii) reactions and adjustments of non-engineers.

Some changes in engineering teaching are suggested to develop a scientific and human attitude. An engineer should have a dynamic approach in these changing times and deserves proper recognition for his work. He cannot escape from social responsibilities and live in a purely technical world. Modern Society is largely a result of his own creations and he is duty bound to take part in social activities. His engineering background can be of immense benefit in public service. How is he justified in delegating his responsibilities of citizenship to others generally less competent?

Man should always be ancillary to machines and not a slave to them. Proper education and personal involvement are remedies suggested to overcome human tendency to resist change. Putting modern techniques to practice raises problems economic, psychological and political in nature and a slow and steady change is the outcome.

7. **DR. S. K. CHATTERJI** (Calcutta) : *Total Rehabilitation and Social Security—Essentials for the Social implications of technological advance in India.*

With the dawn of Independence in India, she has been advancing slowly and steadily in her social, industrial, educational and political spheres. Experiments, in social and community welfare projects, are being made in various forms with the object of improving the living standards and thereby to have an all round, solid economic development for the 400 million of people living in India with the millions of displaced persons added thereto.

With the technological advancements in science and industries, social implications are growing in number and India has to solve her own problems by her own people. The main social implication is to deal with the man-power. All scientific and industrial concerns need a full man-power for their products and the state must pay its full attention to the health and moral of the working class and the labourers, who are actually handling the machineries in workshops and factories. Workers handicapped with illnesses or disabilities should be treated under special practical methods of "Physical Medicine and Rehabilitation"—which is gaining a wider recognition more in the West than in the East. These practical methods of treatment combined with the usual medical and surgical methods should be popularised in India. Rehabilitation Centres with four basic units—Medical, Psychological, Social and Vocational—with competent professionals in each, should be established in each industrial town, to restore the afflicted victims to the greatest physical, mental, social and vocational usefulness of which he is capable.

Advances and developments in the special line may be made to achieve a total dynamic rehabilitation through research. This would bring in a revolution in the therapeutic line to meet the demand for rehabilitation of the handicapped.

The next question is equally important, that is, to deal with the problem of financial losses incurred by the disables. Aid should be provided for the handicapped, the aged and the neglected to provide a type of social security, for which Social Security Laws should be enacted, and Rehabilitation Centres, as have been established in the West and are doing much good to the individual in particular and the Society in general, should be set up.

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to bring forth this increase, and the construction of investment goods will have to be increased by more than 10%, say 50% or 100%. In a similar way, let us suppose that it is desired to expand education in a country and that one wants to increase the annual output of persons with nursery and primary school education by 10%. Then many new teachers will be needed to bring forth this increase, and the annual output of persons with *secondary* education—the depth level of primary school teachers—has to be increased by *more* than 10%. So we see that the acceleration principle in education means that the output of new labour on *deeper* levels has to be expanded at a *faster* rate than would be necessary in long-run equilibrium. In the dynamic up-swing the national production of teachers and instructors has to be accelerated at a speed that is proportional to the *rate of increase* of the desired number of pupils in schools.

The paper gives an empirical demonstration of the acceleration principle in labour theory on the basis of available data on the number of pupils and expenditure incurred in India during the past few years. The numerical values of the accelerator coefficients are estimated. The education targets of the Second Five Year Plan are analysed with a view to see whether the plan framers have recognised the significance of the acceleration principle in education and given due importance to the schooling of deep labour.

Sample Surveys

12. On Multi-phase Sampling.

R. P. BHARGAVA, Dehra Dun.

In this paper, for a p -variate normal distribution, expressions for the maximum likelihood estimate of the mean of the k^{th} phase variate x_k ($=2, 3 \dots p$) is obtained when the sampling is multi-phase and at random. The variance of the estimate of mean is expressed as a function of the population parameters, maximum likelihood estimates of each one of which is determined. Thus the best estimate of the variance is made available. Its large-sample first approximation is indicated. Some special cases are discussed. In the process of deriving these results the maximum likelihood estimates of the parameters of a p -variate normal distribution when the data are incomplete and of the multi-phase type are obtained.

When the sample is large and regressions linear, expressions for the estimate of mean of the last-phase variate and for its variance are derived without making any assumptions as to the form of the parent population for some special cases. Some of these cases are applicable to problems of sampling on successive occasions.

13. Sampling Error of the Regression Estimate when the Population is Finite.

M. V. JAMBUNATHAN, Mysore.

Let y be the principal character having mean $\bar{Y}$ and variance σ_y^2 in the population, and let x be an auxiliary character with known mean $\bar{x}$ and having correlation ρ with y . If a random sample of size n is drawn, the estimate of $\bar{Y}$ is given by

$$\bar{Y}' = \bar{y} + b(\bar{X} - \bar{x})$$

where $\bar{x}$, $\bar{y}$ are the means of x and y respectively in the sample, and b is the estimate of the regression of y on x based on the same sample. The estimate of the mean of y has variance

$$V(\bar{Y}') = \sigma_y^2 \left\{ \frac{1}{n} + \frac{(\bar{X} - \bar{x})^2}{\sum (x - \bar{x})^2} \right\}$$

the summation extending over all the n sample elements, and $\sigma_0^2 = \sigma^2 (1 - \rho^2)$ = the residual variance of y . The second term inside the braces of the above expression is the contribution to the variance on account of the regression itself being estimated, and the average value of this term in samples of size n is $1/(n-3)$. When the sample is drawn from a finite population of size N , the function estimating Y is the same as above, but the variance of estimate is now given by the expression

$$S_0^2 \left\{ \left(\frac{1}{n} - \frac{1}{N} \right) + \frac{N (\bar{X} - \bar{\bar{X}})^2}{(N-1) \sum (x - \bar{x})^2} \right\},$$

where S_0^2 is the residual mean square and the summation is over all the n values in the sample. It is shown in this paper that the last term inside the braces occurring in the above expression has average value $1/(n-3) - 1/(N-3)$ in random samples of size n . The final expression for the variance of the estimate in this case has the average value (correct to second order of small quantities) given by the expression

$$S_0^2 \left\{ \left(\frac{1}{n} - \frac{1}{N} \right) \left(1 + \frac{1}{n} - \frac{1}{N} \right) \right\}$$

14. Measurement of Attrition in Technical Education.

K. C. SEAL, New Delhi.

The existing shortage of technical manpower can be partially met by reducing the wastage during the training period of the students admitted for technical training. For proper assessment of attrition during the course of training a detailed cohort study following each student throughout his training period is really required. Such a study for every training institution in the country (unless the total number of such institution are very few) will be a formidable task since, mere collection of such detailed statistics for a number of years about each student admitted in any institution, will be extremely difficult and time-consuming. It is indicated in the present paper how under some realistic model certain broad conclusions regarding wastage can be arrived at from the usually available data for most of the institutions such as (i) total number of admissions each year, (ii) total number of students appearing at the qualifying examination every year and (iii) total number of students qualifying every year.

As for instance, it is shown from an analysis of the available material on (i) and (iii) only that for medical graduates about 90% of the students admitted qualify in about 7 years' time instead of the usual duration of $5\frac{1}{2}$ years. Other examples are also provided.

Section III, Physics

1. On Solutions of He^3 and He^4 : Part II.

S. K. TRIKHA, Delhi.

Recently a theory of He^3 and He^4 solutions has been developed by Trikha and Nanda [Prog. Theor. Phys. 17 (1957), 679], referred to as Part I. On the basis of the theory we have discussed the osmotic pressure, the fountain effect and the heat resistance in He^3 and He^4 solutions. Theory and experiment are found to be in agreement in this case.

Fairly good agreement for the velocity of second sound and the effective "normal fluid" density in solution is obtained, on the basis of this theory, if we assume that

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22nd "	1935,	Calcutta	...	...	...	...	15	0	0
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25th "	1938,	Calcutta	...	...	...	...	30	0	0
26th "	1939,	Lahore	...	...	...	...	20	0	0
27th "	1940,	Madras	...	...	...	...	27	6	0
28th "	1941,	Banaras	...	...	...	...	30	4	0
29th "	1942,	Baroda	...	...	...	...	25	8	0
30th "	1943,	Calcutta	...	...	...	...	19	8	0
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32nd "	1945,	Nagpur	...	...	...	...	18	4	0
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35th "	1948,	Patna	...	...	...	...	23	0	0
36th "	1949,	Allahabad	...	...	...	...	21	12	0
37th "	1950,	Poona	...	...	...	...	23	12	0
38th "	1951,	Bangalore	...	...	...	...	27	12	0
39th "	1952,	Calcutta	...	...	...	...	32	6	0
40th "	1953,	Lucknow	...	...	...	...	36	0	0
41st "	1954,	Hyderabad (Deccan)	...	...	...	...	28	0	0
42nd "	1955,	Baroda	...	...	...	...	33	3	0
43rd "	1956,	Agra	...	...	...	...	36	2	0
44th "	1957,	Calcutta	...	...	...	...	35	6	0
45th "	1958,	Madras	...	...	...	...	39	4	0
46th "	1959,	Delhi	...	...	...	...	41	0	0

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